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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

SUBCOMMITTEE ON REGULATORY POLICIES & PRACTICES

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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

ACRS STAFF PRESENT:

GIRIJA SHUKLA, Designated Federal Official

STEPHEN DINSMORE

JOHN HONCHARIK

RICHARD JERVEY

STEVEN JONES

MATTHEW MITCHELL

SIMON C. F. SHENG

ALSO PRESENT:

CALVIN DUCHARME, Mitsubishi Nuclear Energy Systems

BRUCE KNOBLOCH, Mitsubishi Heavy Industries*

*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

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

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

CHAIRMAN STETKAR: Thank you very much.

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

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

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

CHAIRMAN STETKAR: Thank you very much.

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

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

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

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

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

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

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

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

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

Simon?

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

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

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

DR. SHENG: Do you want the answer now?

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

DR. SHENG: Right. Okay.

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

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

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

The second page I would like to -- the overview -- and let me see, I think -- okay, overview. First I am going to talk about the GDC 4 requirement.

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

DR. SHENG: Okay.

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

DR. SHENG: Okay.

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

DR. SHENG: Okay.

CHAIRMAN STETKAR: -- otherwise our recorder --

DR. SHENG: Did it affect my volume?

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

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

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

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

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

And next, I'm going to discuss industry

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

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

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

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

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

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

DR. SHENG: It's near the end.

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

DR. SHENG: Yes.

CHAIRMAN STETKAR: Thanks.

DR. SHENG: Okay, so the GDC 4,

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

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

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

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

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

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

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

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

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

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

Now, let's go to the objectives of the

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

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

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

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

DR. SHENG: From a systems point of view.

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

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

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

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

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

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

CHAIRMAN STETKAR: Absolutely.

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

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

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

10^{-7} is a frequency for a high trajectory or for a missile impacting an essential -- one essential component.

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

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

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

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

MR. JONES: Right.

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

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

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

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

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

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

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

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

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

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

CHAIRMAN STETKAR: Oh, Steve is coming?

DR. SHENG: Yes.

CHAIRMAN STETKAR: Okay, great.

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

CHAIRMAN STETKAR: Okay.

DR. SHENG: Just to discuss in that direction.

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

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

DR. SHENG: Yes, until he arrives.

CHAIRMAN STETKAR: Sure. Sure. Thanks. I'm sorry.

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

CHAIRMAN STETKAR: Yes, continue.

DR. SHENG: Until Steve shows up.

So, that's the second objective.

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

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

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

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

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

DR. SHENG: Right, but --

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

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

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

CHAIRMAN STETKAR: Okay.

MR. JONES: Yes, this is Steve Jones.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

MR. JONES: Right.

CHAIRMAN STETKAR: That you are trying to get --

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

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

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

CHAIRMAN STETKAR: Thanks.

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

had the summary of other operating experience before 1995.

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

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

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

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

CHAIRMAN STETKAR: Do you know, does that

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

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

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

CHAIRMAN STETKAR: For a nuclear plant.

DR. SHENG: For a nuclear plant, right.

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

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

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

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

DR. SHENG: Pressures.

MEMBER BLEY: -- pressures, yes.

DR. SHENG: Yes.

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

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

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

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

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

DR. SHENG: Nuclear power plants, right.

MEMBER BLEY: Did you find anymore events?

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

MEMBER BLEY: Okay.

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

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

And, since I mentioned P_1 and P_4 here, so maybe it's the right page that I define P_1, P_2 and P_3. And, of course, our ultimate concern is P_4, which is a probability of failure of an essential system, caused by turbine missile, that's P_4.

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

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

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

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

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

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

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

CHAIRMAN STETKAR: Just be careful with your microphone.

DR. SHENG: Sure. Okay.

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

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

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

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

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

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

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

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

So, after this Salem 2 event, we can say

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

CHAIRMAN STETKAR: We had one event in 1991.

DR. SHENG: Yes.

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

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

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

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

DR. SHENG: That's correct.

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

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

CHAIRMAN STETKAR: And now?

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

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

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

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

But --

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

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

CHAIRMAN STETKAR: Right.

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

But, among the low pressure turbines, they

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

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

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

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

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

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

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

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

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

So --

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

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

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

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

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

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

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

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

MR. HONCHARIK: This is John Honcharik again.

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

valves.

CHAIRMAN STETKAR: Okay, thank you.

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

DR. SHENG: You mean Salem 2?

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

DR. SHENG: 1995, right.

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

DR. SHENG: 1995, right. Right.

MEMBER BLEY: Okay.

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

MEMBER BLEY: 10?

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

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

MR. JONES: I have a copy of it.

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

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

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

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

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

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

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

So, if we don't have that single event, then probably the proposed RG 1.115 would be different, because then we are going to use a more elaborate statistic approach, probably to justify for lower criteria for P_1 and P_4.

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

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

CHAIRMAN STETKAR: 1973.

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

CHAIRMAN STETKAR: It did?

DR. SHENG: It did, right.

CHAIRMAN STETKAR: Okay. Thank you.

DR. SHENG: Because of this -- because we made the congruency, the operating experience is still consistent with current RG 1.115, so we maintain the current criteria of P_1 and P_4. We didn't try to lower the standard.

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

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

DR. SHENG: Right, yes.

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

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

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

DR. SHENG: Yes.

CHAIRMAN STETKAR: Okay.

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

DR. SHENG: I would say so, because this RG 1.115, actually, allows the people to do the whole analysis, including P_2 and P_3, because based on the Hope Creek criteria, the NRC discouraged the licensee to use P_2 and P_3 approach.

So, just when you under protect your turbine, and you want to use an easier approach, then just give me a P_1 number, and I'll assume the P_1 number to be 10^{-4} for the orientation with turbine, and 10^{-5} for the non-favorable ONG turbines.

So, up to this point, we have, I think, a wide range of industry reports, especially, several reports by EPRI, I notice that the industry beats several -- made some progress in the P_2 and P_3 calculation. And, actually, they have software to do the whole thing.

So, I think this is about time, because it's about almost 15 years, so maybe we should take a very good look at the industry's approach of using -- taking advantage of P_2 and P_3, and that's why we would open -- we make -- we no longer say that we discourage this, we say we have a preferred approach, and we have an acceptable approach. The acceptable approach, we said, you want to use P_1, P_2 and P_3 to protect your turbines.

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

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

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

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

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

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

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

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

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

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

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

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

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

DR. SHENG: I understand.

CHAIRMAN STETKAR: -- regulate investment risk from licensees.

DR. SHENG: Right.

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

DR. SHENG: Right.

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

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

DR. SHENG: Right.

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

DR. SHENG: Yes.

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

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

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

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

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

DR. SHENG: Yes, we have three options.

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

CHAIRMAN STETKAR: Okay. Position 6.

MR. JONES: Yes.

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

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

CHAIRMAN STETKAR: Okay. Okay.

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

MEMBER SHACK: He must have heard.

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

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

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

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

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

MR. SHUKLA: Can anybody call him?

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

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

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

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

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

CHAIRMAN STETKAR: Good.

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

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

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

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

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

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

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

it appropriate to ask --

DR. SHENG: Yes.

CHAIRMAN STETKAR: -- you are, okay.

DR. SHENG: Yes.

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

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

First, I have to -- let's do it that I explain along the way. First off, P_1, the calculation of P_1, how they calculate equal to $P_1 = P_{1f} \times P_{1p} + P_{1o}$. P_{1f} is the probability of this value, based on probabalistic fracture mechanics considering strength corrosion cracking.

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

DR. SHENG: Right.

CHAIRMAN STETKAR: This is the disk coming apart.

DR. SHENG: You are right.

CHAIRMAN STETKAR: At less than 130 percent overspeed.

DR. SHENG: You are right.

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

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

And, this is, the second one, P_{1o} will fail in a total manner at much higher speed.

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

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

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

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

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

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

DR. SHENG: That's correct.

CHAIRMAN STETKAR: For each submittal.

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

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

CHAIRMAN STETKAR: So, does the staff look

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

DR. SHENG: Yes.

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

DR. SHENG: Yes.

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

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

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

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

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

DR. SHENG: Right. Right. Right.

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

DR. SHENG: Right.

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

DR. SHENG: Right.

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

DR. SHENG: Right.

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

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

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

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

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

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

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

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

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

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

MEMBER SHACK: But, you know, the

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

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

CHAIRMAN STETKAR: An example, we haven't talked about P_{1o}, but something that I've seen, just looking at a couple of submittals, I think I read somewhere that from -- I think it was in the Bush report, that the primary contributor to severe overspeed failures was not, necessarily, failure of the turbine protection logic, it had a reasonably significant contribution from failures of the turbine top valves failing to close.

I've seen at least a couple turbine

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

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

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

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

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

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

And then, the third item, the P_{1o}, that's overspeed protection system, and as it was mentioned before by Dr. Stet --

CHAIRMAN STETKAR: Stetkar, that's close enough.

DR. SHENG: -- Stetkar.

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

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

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

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

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

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

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

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

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

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

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

CHAIRMAN STETKAR: That's why I was curious when you say it's based on the Hope Creek SER. The Hope Creek SER is silent on high trajectory missiles.

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

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

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

CHAIRMAN STETKAR: The Hope Creek SER simply uses numbers.

DR. SHENG: Right.

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

DR. SHENG: Right.

CHAIRMAN STETKAR: They are simply numbers.

DR. SHENG: Right, you are correct.

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

topic areas, let me show it here.

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

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

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

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

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

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

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

DR. SHENG: Yes.

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

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

DR. SHENG: Right.

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

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

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

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

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

DR. SHENG: Control --

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

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

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

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

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

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

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

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

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

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

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

MR. JONES: This is Steve Jones.

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

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

Reg Guide that makes this type of differentiation.

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

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

DR. SHENG: Right.

MR. JONES: Right.

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

DR. SHENG: Right.

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

DR. SHENG: That's correct.

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

DR. SHENG: Right.

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

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

equation that you showed earlier.

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

DR. SHENG: Right.

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

DR. SHENG: That's --

MR. JONES: It's bounded, basically.

DR. SHENG: It's bounded, basically.

CHAIRMAN STETKAR: Why is it bounded?

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

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

CHAIRMAN STETKAR: Yes.

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

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

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

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

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

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

CHAIRMAN STETKAR: And, we just know that?

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

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

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

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

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

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

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

MEMBER BLEY: Overspeed.

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

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

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

So, in general, you know, very high exit

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

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

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

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

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

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

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

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

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

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

MR. DINSMORE: That would be great.

MEMBER BLEY: We can always take a break.

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

MR. DINSMORE: Okay.

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

MR. DINSMORE: Thank you very much.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

DR. SHENG: Yes, let me explain that.

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

MR. JONES: Wait a minute, Simon.

CHAIRMAN STETKAR: Oh, this could be interesting now.

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

MR. DINSMORE: There's three or four of

them.

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

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

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

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

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

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

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

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

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

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

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

CHAIRMAN STETKAR: There's a number in there.

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

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

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

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

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

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

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

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

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

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

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

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

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

DR. SHENG: Right, right, right.

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

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

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

CHAIRMAN STETKAR: Good.

DR. SHENG: Okay?

CHAIRMAN STETKAR: Thank you.

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

DR. SHENG: Was it about the risk?

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

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

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

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

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

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

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

CHAIRMAN STETKAR: Right.

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

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

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

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

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

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

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

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

contributor to the rest of the risk of the plant?

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

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

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

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

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

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

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

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

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

MR. HONCHARIK: This is John Honcharik.

I guess we'd have to decide how that would be captured then, you know, that new criteria, I mean. Are you going to have a different Reg Guide for new reactors? It just doesn't seem prudent, since it's, basically, using the same turbines, they are using replacement turbines now that, basically, will be the same turbines that will go into a new plant.

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

little more thoroughly.

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

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

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

inspection of the turbine rotor. Okay?

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

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

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

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

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

MR. HONCHARIK: Right.

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

That's pretty much up to them.

MR. HONCHARIK: Right.

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

MR. HONCHARIK: Right.

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

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

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

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

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

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

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

It's certainly not, you know, prudent to

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

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

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

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

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

CHAIRMAN STETKAR: I'm kind of lost.

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

DR. SHENG: Right.

MR. DINSMORE: The next slide is --

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

going to talk about is the observation of the industry initiative

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

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

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

CHAIRMAN STETKAR: These are back-up slides now.

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

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

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

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

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

original?

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

Okay, so --

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

DR. SHENG: -- page 15.

CHAIRMAN STETKAR: Slide 15.

DR. SHENG: Slide 15, right.

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

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

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

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

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

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

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

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

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

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

Also, we allow the consideration of robust rotor designs, that it can be reflected in the P_1 calculation.

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

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

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

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

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

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

precise word.

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

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

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

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

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

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

CHAIRMAN STETKAR: Topical reports might work for design certification, where you have a reasonably well established configuration of the plants, because if they are going to do a risk-informed approach, typically, they'll be looking at P_1, and P_2, and P_3, which depends on the actual configuration.

DR. SHENG: I understand that.

CHAIRMAN STETKAR: Not only the turbine itself.

DR. SHENG: Right.

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

DR. SHENG: Yes.

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

DR. SHENG: Right. Right.

CHAIRMAN STETKAR: For a new plant design.

DR. SHENG: Yes.

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

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

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

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

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

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

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

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

DR. SHENG: Okay. Good.

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

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

The second bullet, that the proposed RG 1.115 is consistent with the current criteria emphasizing P_1, which is the preferred approach.

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

CHAIRMAN STETKAR: Good, thank you.

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

DR. SHENG: Okay.

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

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

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

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

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

MEMBER BLEY: Yes.

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

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

MEMBER BLEY: But you could have done that within the P_1, P_2, P_3 arrangement by considering the barrier effect, I guess, in P_2.

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

MEMBER BLEY: Okay.

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

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

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

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

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

MR. JONES: Right.

CHAIRMAN STETKAR: Okay. Then I get that.

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

If P_1 is greater than 10^{-4}, you think the review for defense-in-depth would be, essentially, so significant it's probably not worth going that route? And, you'd want barriers such that the equivalent of P_2 is zero, nothing is going to happen.

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

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

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

And, from their whole suite of calculations, kind of the conclusion that fell out of that was, P_3 is one. If the missile gets into the room and doesn't go straight out the other side, it bounces around in there like a pinball to the extent that anything inside there is chewed up. And, they did that for lots and lots of different cases, and it just kind of said P_3s.

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

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

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

MEMBER BLEY: This is strictly P_1.

DR. SHENG: P_1.

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

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

MEMBER BLEY: Which involve P_3.

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

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

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

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

CHAIRMAN STETKAR: And, numbers that were,

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

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

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

CHAIRMAN STETKAR: Okay.

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

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

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

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

Anything else? No? Any other questions?

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

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

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

MEMBER BLEY: -- Stetkar, cited by --

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

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

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

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

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

MEMBER BLEY: Yes.

MR. JONES: I agree with that.

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

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

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

CHAIRMAN STETKAR: Anything else, Dennis and Bill?

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

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

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

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

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

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

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

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

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

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

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

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

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

CHAIRMAN STETKAR: Yes, it is, welcome.

MR. KNOBLOCH: I'm opened up.

CHAIRMAN STETKAR: Thank you.

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

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

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

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

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

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

DR. SHENG: Okay.

MR. KNOBLOCH: They have Cases A through D.

DR. SHENG: Oh, yes.

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

DR. SHENG: Right.

MR. KNOBLOCH: Cases B through D are getting into operability and, you know, scheduled maintenance, things like that, and I believe that the P_1 calculation is strongly influenced by testing and maintenance programs.

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

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

MR. KNOBLOCH: Okay. You may want to just

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

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

CHAIRMAN STETKAR: Anything else, sir?

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

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

MR. KNOBLOCH: Calvin, are you there?

MR. DUCHARME: Bruce --

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

MR. DUCHARME: Bruce, can you hear me?

MR. KNOBLOCH: I can hear you, yes.

MR. DUCHARME: Yes.

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

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

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

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

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

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

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

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

We are on mute again, Theron, I hope.

Thank you.

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

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

Regulatory Guide or revision would be issued?

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

MR. JERVEY: Rick Jervey from --

CHAIRMAN STETKAR: Come up to the microphone.

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

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

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

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

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

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

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

MR. DUCHARME: Okay.

MR. JONES: Only Standard Review Plan.

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

MR. DUCHARME: All right, thank you.

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

MR. DUCHARME: Okay, thank you.

CHAIRMAN STETKAR: Anything else?

Yes, Girija?

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

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

MR. SHUKLA: Okay, that's fine.

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

MR. SHUKLA: Right.

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

MEMBER SHACK: Let him know.

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

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

DR. SHENG: Yes.

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

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

MR. SHUKLA: Okay, sure.

CHAIRMAN STETKAR: Good, thank you.

MEMBER BLEY: I have one last thing.

CHAIRMAN STETKAR: Okay.

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

DR. SHENG: I know.

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

DR. SHENG: Right.

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

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

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

MEMBER BLEY: Okay.

DR. SHENG: So --

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

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

MR. MITCHELL: Okay.

DR. SHENG: Yes.

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

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

CHAIRMAN STETKAR: Yes.

MEMBER BLEY: It might seem odd to others,

maybe not.

CHAIRMAN STETKAR: Okay.

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

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

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

CHAIRMAN STETKAR: Anything else?

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

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

MR. DINSMORE: Always a pleasure.

CHAIRMAN STETKAR: Appreciate that.

And, again, thank you very much.

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

Okay, thank you.

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

MEMBER BLEY: Not me.

MEMBER SHACK: Not me.

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

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

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

DR. SHENG: Thank you.

(Whereupon, the above-entitled matter was concluded at 3:59 p.m.)

Proposed RG 1.115, Protection Against Turbine Missiles

Simon C. F. Sheng
Division of Component Integrity

Steven Jones
Division of Safety Systems (NRR)

John Honcharik
Division of Engineering (NRO)

ACRS Subcommittee Meeting
October 4, 2010

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

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

<u>Before 1995</u>

- NUREG-1275

<u>After 1995</u>

- 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

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<u>The Ultimate Concern</u>: 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 1E-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 1E-4 per Turbine-Year (RG 1.115)
- Maintain the Current Criteria of P_1 (Hope Creek SER) and P_4 (RG 1.115)

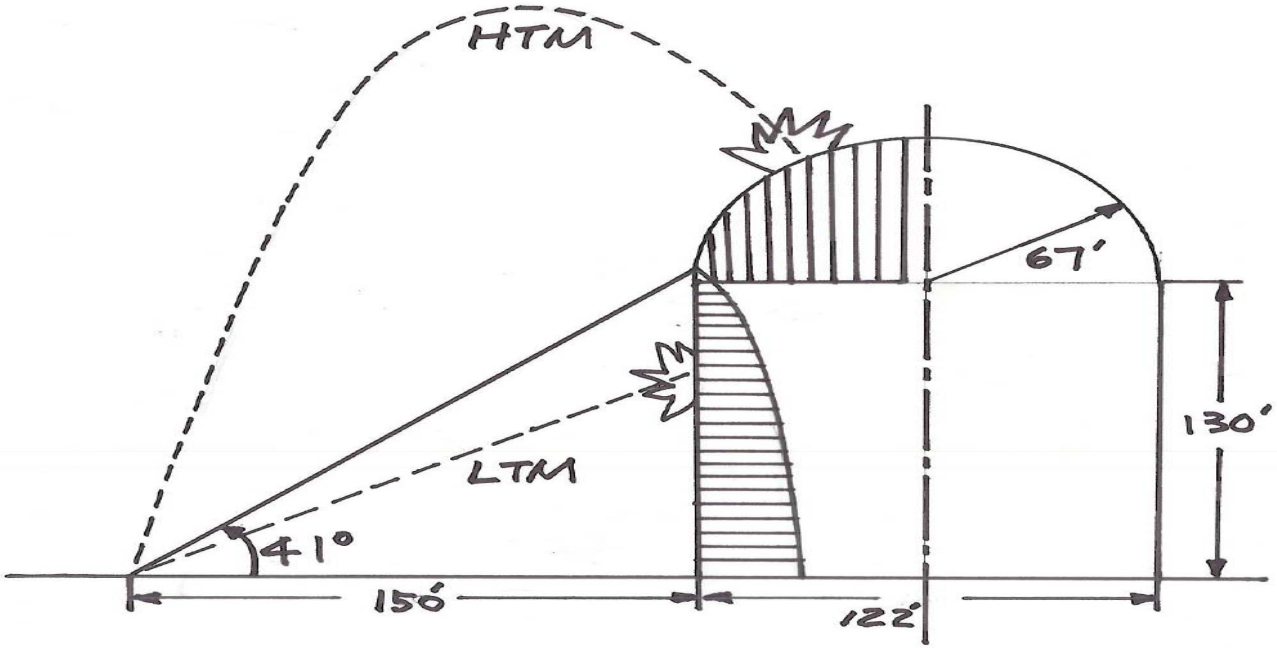
Application of a Risk-Informed Approach

- 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_1s 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

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Unfavorably Oriented/Both Trajectories

P_1 (<1E-4) x P_2 x 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

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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