UNITED STATES

NUCLEAR REGULATORY COMMISSION

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MEETING WITH ADVISORY COMMITTEE ON REACTOR

SAFEGUARDS (PUBLIC)

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THURSDAY,

APRIL 5, 2018

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ROCKVILLE, MARYLAND

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The Commission met in the Commissioners' Hearing Room at the Nuclear Regulatory Commission, One White Flint North, 11555 Rockville Pike, at 10:00 a.m., Kristine L. Svinicki, Chairman, presiding.

COMMISSION MEMBERS:

KRISTINE L. SVINICKI, Chairman

JEFF BARAN, Commissioner

STEPHEN G. BURNS, Commissioner

ALSO PRESENT:

ANNETTE VIETTI-COOK, Secretary of the Commission

MARGARET DOANE, General Counsel

ACRS MEMBERS PRESENT:

MICHAEL CORRADINI, ACRS Chairman

CHARLES BROWN, JR., Member

DANA POWERS, Member

JOY REMPE, Member

JOHN STETKAR, Member

C-O-N-T-E-N-T-S

P R O C E E D I N G S

10:00 a.m.

CHAIRMAN SVINICKI: Okay, so, now we will convene the Commission's meeting with the Advisory Committee on Reactor Safeguards.

I ask the presenters of the Committee for today's meeting please join the Commission at the table.

While you do that, I will announce the last moving piece that I needed to remember which is that large swaths of the United States this morning are participating in a test of the National Emergency Alert System.

This is not the local alerts that you opt into or out of on your phones. So, mobile devices across the country, including the area of Montgomery County is participating in this this morning.

So, some -- between now and 11:00 a.m., it is expected that all activated emergent of cell phones, if you leave them on and not in airplane mode or if you don't turn them off, they will active in some form, again, every device will receive this, this is a test.

Of course, if they don't receive this alert, then that's very newsworthy as well. It would mean that the test in this region failed. But, this is the National Alert System.

Of course, the Nuclear Regulatory Commission has a strong attention and focus on emergency preparedness and emergency planning. So, I'm going to leave it up to every person in the room whether or not you would like to silence your device.

If you don't silence it, turn it off or put it in airplane mode. You will be alerted by your own or your neighbor's, but I think there's a good

chance that some phone will be left active in this room.

So, we're going to have a good chance of hearing this, but there's a -- we shall not react with any kind of irritation over it because it's very important, being as our colleagues in Hawaii learned recently these types of things are important.

Oh, it's happening? Is it not -- is it a silent activation? Because I don't hear any -- wow, did everyone actually silence their phones? That's kind of phenomenal. Well, it's not very attention getting if it was --I'm going to need more than that if I need to run for my life.

(Laughter)

CHAIRMAN SVINICKI: Okay, all right, well, that was it, okay. So, it happened as I was talking about it.

Okay, with that dispositioned then, we can begin the Commission's meeting this morning.

It is our semiannual meeting with NRC's independent Advisory Committee on Reactor Safeguards which, again, was created in the original Atomic Energy Act.

So, this Committee has a very long history of engaging with the Atomic Energy Commission and now the Nuclear Regulatory Commission.

We will hear on a set of topics that are just as subset of the Committee's activities over the time since we last met with them. But, we look forward to that.

And, we will begin this morning with the ACRS Chairman.

Do either of my colleagues have any introductory remarks?

Thank you, Commissioner Baran.

COMMISSIONER BARAN: Just briefly, I would note that,

as the Chairman mentioned, this is really an august body with a long and proud history.

And, in recent years, or maybe even in not so recent years, a big part of that was the participation of Dana Powers and John Stetkar. I think this is your last meeting with us.

We will do our best to make it memorable for you.

(Laughter)

COMMISSIONER BARAN: I promised them that that would happen, so thank you.

But, let me just say thank you so much for your many years of service and the tremendous contributions you've made over those years. We really appreciate it.

Thank you.

CHAIRMAN SVINICKI: Thank you.

Commissioner Burns? Just you associate yourself with your --

COMMISSIONER BURNS: I associate with my colleagues remarks.

CHAIRMAN SVINICKI: -- remarks. Okay.

All right, well, I'll save the fun stuff for when I do my Q&A. So --

(Laughter)

CHAIRMAN SVINICKI: -- we'll do that then.

So, we will then -- now, I will hand the meeting over to ACRS Chairman, Dr. Michael Corradini, please proceed.

DR. CORRADINI: Thank you very much.

I think those slides will be coming up shortly. Excellent, so I will give you an overview, if we go to the next slide, please.

So, since our last meeting with the Commission in October, we've issued 11 reports. We've divided them up into groups.

The first five are topics that you'll hear from the individual members, the first being NuScale Power Exemption Request from 10 CFR 50 Appendix A which is the General Design Criteria 27, Combined Reactivity Control Systems Capability.

This is a SECY address, SECY that's detailing the staff's evaluation for Criteria 2 use for the Exemption Request.

The second thing you'll hear about today is our letter report on Revision 3 to the Reg Guide 1.174. This was an expanded discussion and guidance on defense in depth.

And, since you've already got ahead of me, this will be given to us by Member Stetkar, which we're quite happy he's here, at least this meeting.

The third letter report that we'll discuss with you is State of the Art of Reactor Consequence Analysis, or SOARCA. It's a project on Sequoyah integrated deterministic and uncertainty analyses.

This focused on the unique aspects of an ice condenser plant hydrogen control and Member Stetkar will talk about this.

Next, a report on the safety aspects of the construction permit application for Northwest Medical Isotopes, LLC, which is a radioisotope production facility. And, Member Powers will discuss this with you.

And then, finally, the biennial review and evaluation of the

NRC Safety Research Program. This, in particular, is interesting because, under Dr. Rempe's leadership, it's a revised reports on review of the RES activities.

So, the next slide discusses some of the other reports we've done. One is the Safety Evaluation for Topical Report on AURORA-B, an evaluation model for BWR Application to Transient Accident Scenarios.

AURORA-B is a new methodology that has been advanced and we looked at it in relative to transient accident scenarios. In particular, it has the ability to consider thermal conductivity degradation as part of the method.

Next one is Safety Evaluation of the NuScale Topical Report on applicability of AREVA fuel methodology for NuScale design. One thing, we're going to keep on mentioning AREVA. AREVA's renamed itself to Framatome, but we skipped over that, so you'll see a lot of AREVA.

But, in particular, this one is the methodology since AREVA fuel will be used -- Framatome fuel design will be used in the NuScale proposed reactor design.

This is essentially looking at the applicability of fuel analysis methodology.

Next slide, please?

We've also issued a report on the Safety Evaluation of the Topical Report on the PLUS7 Fuel Design which is to be used for the APR1400.

Also, a Safety Evaluation on AURORA-B for its evaluation and BWR is a control rod drop accident. There's additional methodology or analysis capability that we reviewed in this topical report.

Next slide, please?

We also looked at Reg Guide 1.232, Guidance for Developing Principle Design Criteria for Non-Light Water Reactors.

I'd only mention here that this is one of a group of topics that staff is bringing in front of us for a non-LWRs, the other being License Modernization Framework and the Functional Containment's Policy paper which we'll mention is something we'll be considering in the future.

Next slide, please?

So, in this area of design certifications, we are currently in the midst of or finishing up the APR1400. This, we expect to be done with sometime in the summertime.

And, we've just begun the NuScale Design Certification. Most of our activity so far has been relative to topical reports which we've received in advance of that and we've issued a few letters, as I've mentioned previously.

We're in -- we've just begun looking into the early site permit at Clinch River for Small Modular Reactors. And, this, we've had one information meeting and we will continue to have others in the future.

And then, finally, on this slide, I mention that we're going to be discussing Brunswick Units 1 and 2 and their use of -- their proposed use of MELLLA+ methodology.

Next slide, please?

For license renewals, we're in the midst of three, one being Seabrook, the other being Waterford Unit 3 and then River Bend. And, these will be brought up to us in the next few months.

And, finally, for AP1000, there is a new WCAP assessing

potential debris generation for AP1000 cables and non-metallic insulation, which relates to the GSI-191 methodology that's being -- has to be used for the AP1000. In fact, that topic will be talked about with us at our meeting this week.

Next slide, please?

We also had some ongoing reviews of Regulatory Guidance. For example, the Draft Regulatory Guide DG-1327 on reactivity-initiated accidents. This is a modification of the ruling -- of the guidance, excuse me, with the rule on RAIs.

And then, NUREG on high burnup fuel storage and transportation.

And, finally, NUREG/BR-0058. If you forget what this is like I do, what that is, essentially, a guidance on performing cost benefit analysis. And, in particular, this is coming back to us because we'll hear public comments as well as a finishing of the appendices that were affiliated with the NUREG.

And then, Advanced Reactors, I've already mentioned the two other things that are going to be coming from us, one actually, this meeting, we'll be talking about the functional containment policy paper which will be going to the Commission.

And then, licensing modernization framework which we'll probably hear from in June, at least that's the plan.

Next slide?

In the area of digital I&C, ISG-06 revision, if you remember, this is a licensing approach for completion of reviews for application of new or installing digital I&C system upgrades into operating plants.

Secondly, a diversity in defense in depth against common cause failure. We're expected to get an info paper from the staff on this which we'll then be having a meeting and discussing.

And then, the ongoing living document of the integrated action plan.

Finally, in terms of rulemaking, we're expecting to get something from the staff on Emergency Preparedness for SMRs. And, there's an amendment to the proposed rule for non-power production or utilization facilities such as research reactors.

Next slide, please?

In thermal hydraulics, we're still with GSI-191. The PWR Owners' Group is going to be coming to us, expected to come to us to discuss new in vessel debris test results.

And, finally, with AREVA or Framatome, the AURORA-B methodology is going to be -- come back to us in a topical report applying it to essentially to LOCA analysis. And then, we'll look at that in the next couple months.

In metallurgy and reactor fuels, we just actually heard a -- we just had a Subcommittee meeting on consolidation of dry cask and dry fuel storage standard review plans.

Next slide?

And then, finally, for reliability and PRA, we have our ongoing review of the Level 3 PRA. I think our next meeting full, excuse me, Subcommittee meeting on that will be in May.

And, we're continuing to follow Human Reliability Analysis methods developed on whether it would be the IDHEAS program or control

room abandonment risk.

So, that's a quick rendition of where we are. So, I'll go to the individual talks. I'm actually on next for GDC-27. So, I'll just simply move on to that one.

If we could have that up? Okay.

Next slide, please?

So, for GDC-27, the general design criteria are the minimum requirements for principle design criteria for water-cooled nuclear plants to provide reasonable assurance that the facilities can be operated safely.

And, historically, GDCs were based on the licensing of the early commercial water-cooled reactor plant designs.

Since then, staff has acknowledged that fulfillment of some of the GDCs may be -- may not be necessary or appropriate for some designs. And, in particular, NuScale is a bit of a different plant. It's a modular passive water-cooled reactor design with some innovative design features.

Next slide, please?

So, just to start off with this, the GDC-27 states the reactivity control system shall be designed to have a combined capability in conjunction with poison addition by the emergency core cooling system of reliably controlling reactivity changes to assure that under postulated accident conditions and with appropriate margin for stuck rods, the capability to cool the core is maintained.

So, a long-term core cooling is the key here with reactivity control.

Next slide, please?

So, the staff has historically interpreted the intent of GDC-

27 to require that the reactor be reliably controlled in normal operation and also achieve and maintain a safe shutdown condition, including subcriticality beyond the short-term using only safety-related equipment following a design basis event with margin for stuck rods.

What that really means is, under Chapter 15 assumptions, a DBE scenario is one of the most high worth control rods would fail to insert. There'd be an assumption of loss of offsite AC power and any non-safety system will not work, in particular, the non-safety boron injection system would be unavailable.

In the NuScale design, that leads to a return to power above decay heat levels only when you have the moderator temperature coefficient is sufficiently negative and the reactor core temperature gets low enough.

So, under those conditions, staff felt there was a need for an exemption request. Staff informed NuScale of that exemption request will be required for its reactor design.

Next slide, please?

So, NuScale submitted the request for the exemption on GDC-27. The staff came back, or and I should say, it should be recognized that many times, exemptions to current GDCs may be needed as design changes or innovations are proposed.

So, staff came back and plans to evaluate whether the NuScale design meets the underlying intent of the GDC and assures public health and safety based on two key criteria.

The first being that it demonstrates sufficient core cooling. What this really means is the staff is coming through to assess the results of the NuScale safety analysis of the assumed design basis accident scenarios

against established, specified, acceptable fuel design limits. I'm going to come back and use the word SAFDL. So, I thought I'd say it at least once. Right?

But, essentially, fuel design limits have to be maintained in the long-term.

Secondly, the staff felt that the design basis accident sequence of events should not be expected to occur during the lifetime of a module.

And, just a parenthetical here, Commission will make the final determination of the acceptability of the NuScale exemption. So, this essentially in preparation for that discussion.

Next slide, please?

Under the topic of maintaining the long-term core cooling, to assure long-term core cooling, we, that is the ACRS, expect that NuScale will perform an evaluation to ensure the SAFDLs fuel design limits are not exceeded for any of the DBE scenarios considered.

And, we think the analyses would conclude consideration of operator actions, estimates of the return to power and the associated strategies to return to a subcritical condition and assurance that the margin does not degrade over the duration of the event.

Next slide, please?

In terms of low probability of return to power, the staff's evaluation criteria, we came back and felt there should be additional criteria to augment what is proposed.

First, that an assessment of the incremental risk to the public health and safety from the hypothetical situation.

And, secondly, that the risk increase is acceptable but it considers the entire NuScale facility, not just a single module.

So, those are the two things that we've come forward to and what we feel ought to be augmented in terms of criteria.

I'll only mention here that, inclusion of the risk evaluation or risk acceptance really is line and consistent with Reg Guide 1.174.

Next slide, please?

So, for low probability of return to power, the non-safety SSCs that provide boron addition should also have certain characteristics. They should not degrade during plant operation and they should function reliably when called upon including operator actions that are needed for startup and their alignment.

So, our conclusion and recommendation is to propose criteria reasonable for judging the exemption request provided the following recommendation enhancements are made.

One, that we evaluate the overall risk, not just the frequency of the challenge.

And, secondly, that the risk consideration should be based on the facility rather than any individual module.

Okay? Thank you very much. So, I'll turn now to Member Stetkar and he's up for a couple of discussions with you on topics.

MR. STETKAR: Great, thank you.

May I have the first slide, please?

The first topic I'm going to discuss is Revision 3 to Reg Guide 1.174.

This Reg Guide describes the key principles and guidance

for the use of risk information in regulatory decisions.

Over its life, it's become the fundamental reference for use of risk information by both the staff and the industry. So, it's one of the key Reg Guides that this organization has developed.

One of those five key principles for integrated decision making is that a proposed change should be, quote, consistent with defense in depth philosophy.

And, historically, both industry and the staff have had difficulties with understanding what is needed to demonstrate how that principle has been satisfied.

So, the primary impetus for Revision 3 to the Reg Guide is to clarify the guidance for how defense in depth should be considered by both an applicant and the staff.

Next slide?

As part of the SMR on SECY-15-0168 which was the Commission's SECY -- the Commission's SRM on the recommendations for the risk management regulatory framework in NUREG-2150. I'm sure you're all familiar with these SECY numbers.

The staff actually directed the -- the Commission directed the staff to expedite this Revision 3 to the Reg Guide.

We conducted four Subcommittee meetings on Rev 3 to the Reg Guide between May 2016 and August of last year. And, we had previously reviewed what is, if you haven't read it, read it, an excellent NUREG knowledge document on the defense in depth philosophy NUREG/KM-0009 as part of our deliberations on the risk management regulatory framework.

We spent quite a bit of time studying that document. And,

it is an excellent compilation of the history of defense in depth in this Agency.

Next slide?

We recommended that Revision 3 of Reg Guide 1.174 should be issued. And, in fact, it was issued in January.

We noted that it substantially expands and clarifies the guidance for consideration for defense in depth and its integration with the other risk informed decision making principles.

Revision 3 also clarifies the staff's intent for determining the technical acceptability of a PRA for use in these types of risk informed decision. And, it enhances the guidance on evaluation and treatment of uncertainties.

Next slide?

We understand that the staff plans a future Revision 4 of Reg Guide 1.173 to expand the guidance on integrated decision making, and in particular, the use of uncertainly as an input to the decision process.

And, in our letter, we also encouraged the staff to consider extending the guidance to address applications of risk information for new reactors which may have much different risk profiles and overall lower levels of risk in currently operating reactors.

That concludes my discussion of Reg Guide 1.174. I'm going to continue with the next topic which is the State-of-the-Art Reactor Consequence Analysis project for Sequoyah.

Next slide?

The first two SOARCA studies were performed for the Peach Bottom and Surry reactors. The original studies used so-called point estimate values in the calculations without an evaluation of the uncertainties.

Subsequent to publication of the original studies, the staff went back and performed what I'll called focused uncertainty analyses for a small number of selected scenarios in those studies.

Next slide?

However, in most cases, the uncertainties in those focused studies were retrofit around the point estimate values. In other words, the staff essentially backfit an uncertainty analysis.

Those focus studies, however, demonstrated the importance of addressing uncertainties and that consideration of the uncertainties can affect the understanding and overall interpretation of the results. That was an important finding from those focused studies.

Next slide?

The Sequoyah study does two things, first of all, it extends the scope of the SOARCA project to address a PWR with an ice condenser containment, because it's a much different containment than either of the other two plants that were examined.

And, because of that, it's intended specifically to examine the effects of hydrogen generation and release, the timing and locations of ignition and containment vulnerability to failure caused by a highly energetic deflagration. Hydrogen issues have always been a larger concern in these ice condenser type of containment. So, the staff focused primarily on that issue.

Next slide?

The Sequoyah study evaluates the plant response to one short-term station blackout and one long-term station blackout. And, again, I'm sure you're intimately familiar with this, but a short-term station blackout

means that all AC power is lost at the beginning of the event and any cooling or injection systems that rely on AC power are also disabled. So, everything is gone at time T0.

A long-term station blackout allows equipment that does not rely on AC power to run until, for example, the station batteries are depleted. So, long-term station blackout, you lose core cooling or injection capability anywhere from two to eight hours after the event, depending on the life of the station batteries and so forth.

The Sequoyah study assumes that each scenario is caused by a severe earthquake. That's important, the Surry and Peach Bottom studies also did that as just one way of losing electric power.

But, in particular, in the Sequoyah study, the models for offsite emergency response explicitly account for that seismic damage to the local infrastructure so that the evacuation planning, there are delays in evacuation planning due to damage to the infrastructure.

Local bridges over the rivers in that area are disabled by the earthquake, in fact, in the models within I think it was a 10-mile radius that they used. So, they've explicitly accounted both the onsite and offsite effects from that earthquake which was not done at all in the Surry and Peach Bottom studies.

The integrated evaluation of uncertainties for thermal hydraulic is response and offsite consequences were performed for only the station -- the short-term station blackout scenario. So, they didn't do an integrated uncertainty analysis for the long-term blackout scenario.

ACRS engagement, we had three Subcommittee meetings on the Sequoyah SOARCA study between May 2016 and October of last year.

And, we had a separate special Joint Subcommittee meeting in April of last year to be briefed on changes to MELCOR and improvements to modeling in MELCOR that were made specifically to address the hydrogen issues for the Sequoyah study.

Next slide?

Our first recommendation and conclusion was that the Sequoyah study has significantly advanced our understanding of severe accident progression in a PWR with an ice condenser containment.

And, it clearly demonstrates the importance of an integrated assessment of uncertainties about equipment performance from a hydraulic phenomena and emergency planning.

Next slide?

As I mentioned earlier, the study evaluates site-specific conditional consequences from two station blackout scenarios which have been tailored to examine the effects from hydrogen generation ignition and containment failure vulnerability.

It does not examine other scenarios that may be important for containment failure or bypass.

Next slide?

It does not account for accident mitigation strategies that have already been implemented at Sequoyah. So, therefore, it's a very stylized study for even the Sequoyah plant as it’s operated today.

And, therefore, we noted that the results from this study should not be extrapolated to other PWRs with ice condenser containments and certainly not for other sites.

Next slide?

Our third recommendation was that the Sequoyah report should be published after the staff more clearly documents the following three issues.

The first was the treatment of potentially important modeling uncertainties.

A better technical justification for failure rates for, in particular, pressurized or safety valves. Those failure rates are the likelihood that a valve that opens remains stuck open. And, if it does remain stuck open, how far does it remain stuck open? And, that's a very important parameter in this particular study.

And, a better discussion of the reasons for failures to complete some of the MELCOR simulations that involved an early stuck open pressurizer safety valve, though, that particular condition was found to be very important for the conditional likelihood of an early containment failure.

And, a reasonable fraction of the MELCOR runs within that particular regime of the plant response failed to complete. And, we asked that the staff do some better forensics in terms of understanding why and whether or not the runs that failed to complete would affect any overall conclusions from the study.

Next slide?

We also recommended that the staff should examine and resolve the issues regarding the safety valve failure rates that I just mentioned and this MELCOR performance before any further enhancements are made to the other SOARCA studies at Surry and Peach Bottom in particular.

And, finally, the staff has responded to our letter. We've been informed that the final report strongly emphasizes that the study is

specific to only Sequoyah.

The staff has indicated that the report will acknowledge that an evaluation of model uncertainty is outside of the scope of this particular study.

The report contains enhanced discussions of the safety valve failure rates and insights from actually quite an extensive amount of forensics that were done on those incomplete MELCOR runs to provide improved assurance that nothing was lurking there that was unexpected.

And, the staff has also indicated that they will further address the safety valve failure rate issues in the planned updated Surry uncertainty analyses.

That's the end of that topic.

DR. CORRADINI: So, we'll turn to Dr. Powers.

DR. POWERS: We'll shift gears a little bit and move to the discussion of Northwest Medical Isotopes proposal to build a -- for a construction permit.

They propose to develop a facility for producing the medical isotope moly-99. I believe this has been declared a national priority to have a national source for this material to be sure it is one of the most widely used of medical isotope.

When you first look at the Northwest Medical Isotope, there seem to be a lot of moving parts in their proposal, almost Rube Goldberg type of strategy.

As you get into it and look at it, you say, gee, this process may actually work. And, the reason it may work is that they are not relying on either an engineering or a scientific breakthrough. They have selected a

variety -- collaboratively selected a variety of established processes.

And, though we can't underestimate the challenges of a first of a kind engineering of known processes, it looks like it's a very feasible undertaking.

What they have asked for is a construction permit for a facility that will allow them to fabricate uranium targets and subsequently process those targets. The targets themselves will be irradiated at some university research reactor, certainly one in Missouri, maybe one in Oregon and maybe elsewhere.

My personal belief is that there are no good ways for chemically processing special nuclear materials. We have found ways that will work, but they require a great deal of discipline and attention to conduction of operations.

The hazard of processing special nuclear materials, well, always you have criticality hazards. Northwest Medical Isotopes proposed to handle these with a relatively classic mixture of design and double contingency principle safety strategies.

The hazard to the public from this processing facility is the release of radionuclides. They can released radionuclides during the dissolution of the targets after they've been irradiated that will release volatile radionuclides.

They propose to capture those on an assembly of activated charcoal and silver modified zeolites. That is a known process that will work.

The overall design, of course, is a classic nested loops of contamination zones.

The threats to the facility, well, fire. They have fire

potentials of electronic nature, fire potentials for organic materials. They do have some hydrogen processing materials and have an interesting fire hazard associated with uranium metal upon the receipt of special nuclear material for the fabrication of targets.

The external threats to the facility, aircraft impact, seismic. They have an interesting high-frequency seismic that doesn't threaten the structural material structure of the facility but does threat its internals. And, of course, high winds in the area of country where it will be, tornados is a primary concern there. All these seem to be well-addressed.

Our review consists primarily of explaining and elucidating how they must finalize their design in order to meet the requirements for licensing.

Our conclusion was that it should be possible to construct and operate this processing facility in such a way that it poses no undue risk to the public health and safety and we recommended that they be given a construction permit.

DR. CORRADINI: And, finally, Dr. Rempe.

DR. REMPE: Thank you.

So, I'd like to discuss our biennial review and evaluation of the NRC's Safety Research Program.

The ACRS has provided formal reviews of the NRC's Safety Research Program since 1977. As Mike indicated in his opening remarks, we did change the process that we use as well as the format of our report this year, but we still address all of the items identified in the Commission's 1997 guidance to us.

We look at the need, scope and balance of the reactor

safety research program, the progress of ongoing activities and how well the Office of Nuclear Regulatory Research positions the Agency for the future.

But, in our 2018 review, we also emphasized the identification and prioritization of new research needs, longer term planning activities by RES and providing the Commission a more succinct report.

These additional items were motivated by comments that you provided in our October 2016 meeting as well as our desire to provide a better product to the Agency.

The information that you'll find in our 2018 report was developed based on our review of reports issued by the Office of Nuclear Regulatory Research as well as the items listed on this slide.

We started with an initial meeting with Mike Webber, the Director of RES.

We then held three working group meetings with each director of each division within RES.

And then, we had gained insights from our normal ACRS activities, our periodic reviews of research projects of special importance, our reviews of research that impacts regulatory processes and our annual quality reviews.

In the next six slides, I'm going to highlight some of the information you'll find regarding the activities being performed within each division within RES.

Starting with the Division of Risk Analysis, you'll find several comments about various projects that they have underway.

For example, the Level 3 PRA, we observe, is a good example of research that preserve staff skills and Agency tools as well as

advances to the state-of-the-art with respect to risk assessment.

We also provided several comments about the ongoing IDHEAS effort which we followed with periodic reviews during our Subcommittee meetings.

In the letter report, we, again, emphasized the guidance that we're giving the staff regarding the need to move forward with developing a coherent articulation of this method that'll provide a unifying basis for human reliability and meet the intent of the SRM issued on this topic.

In our comments for each division, you'll find general comments that are actually applicable to all divisions within RES.

For example, in our discussion of DRA, we observe it's not clear to us how research priorities accounted for integrated consideration of enterprise risk.

And, by this term, we're talking about the need for an integrated evaluation that considers factors such as safety and security, emerging issues, innovative technologies and associated uncertainties, preservation of core competencies and development and maintenance of analysis methods and tools.

In our discussion of the Division of Systems Analysis, we first emphasize the importance of the Agency having an independent reactor safety analysis capability.

Our letter report describes several ongoing activities to improve and apply DSA computer codes, codes for analyzing fuel performance, FRAPCON, FRAPT as well as evaluating accident progression, TRACE and MELCOR.

We noted that, in light of the Agency's heavy reliance of

severe accident methods, that the Agency should consider identifying and supporting consequence analysis as a core competency.

In our discussion of DSA, we observed that, in light of the current and future projects regarding Agency resources, that difficult strategic choices are required to maintain current computational capabilities and core competencies and to anticipate and adapt to future regulatory needs.

Our discussion offers several solutions to assist DSA in optimizing resources as they make these difficult choices.

And, I would observe that many of those possible solutions are broadly applicable to all divisions in DSA.

In our review of the Division of Engineering, we also provide comments regarding ongoing activities.

For example, we emphasized the importance of computer codes they've developed for assessing material performance, xLPR and FAVOR, for example.

We also encourage the staff to accelerate their reviews of ASME codes and ASTM standards. And, we observed that delays in the reviews and approvals of those codes and standards often leads to additional work by the Agency as well as industry.

And, finally, I wanted to emphasize our comments regarding the need for a risk evaluation prior to embarking on any additional spent fuel dry storage cask research.

And, this stems from our belief that there is not a risk basis for providing any additional research in that area.

Our review of DE also identified several examples that led to general comments.

For example, we encourage the staff to focus on identifying data that licensees or applicants should provide rather than independently developing such data.

We also emphasized the need for an effective process for terminating ongoing research when it ceases to be a high priority.

And, finally, I just wanted to highlight our conclusion and recommendations that you'll see in our letter report. They are related to integrated research priorities by the Agency.

First, we emphasize that it appears to us that the Safety Research Program is meeting near-term Agency needs.

However, we emphasize that a systematic assessment that emphasizes enterprise risk might be improving the processes that is used by the staff in selecting research projects, evaluating as well as determining when they should be terminated.

We observe that results from that systematic assessment could assist the Agency in developing longer term strategies to address emerging technical issues, support development to maintenance of needed analytical tools and databases, emphasize activities that improve regulatory efficiency, and identify and preserve needed core competencies.

Thank you.

DR. CORRADINI: Questions?

CHAIRMAN SVINICKI: Thank you for those presentations and for the other letter reports that the Committee produced over the last six months or so.

We will begin the Commission's question period with Commissioner Burns. Please proceed.

COMMISSIONER BURNS: Well, thank you.

Thank you for the presentations and the opportunity, again, to engage with the ACRS in the Commission meeting. I find it valuable and I think enjoy the presentations and the dialogue we have both formally in this context as well as in our -- some of our drop-in meetings with the individual members.

Maybe I'll just sort of go down the row in the order and I'll start with you, Dr. Corradini.

With respect to the NuScale exemption, you know, you noted the Committee's recommendation the staff's evaluation criteria to be augmented to include an assessment of the overall risks of the hypothetical re-criticality scenario and that other risk considerations should be based on the facility rather than a single module.

The staff has provided a response. It may well be that you're in the process of reviewing that, but I just -- any point at this time, does the Committee feel that the staff is being responsive to the recommendations?

DR. CORRADINI: Yes, I kind of -- we kind of anticipated this might pop up.

COMMISSIONER BURNS: Okay.

DR. CORRADINI: So, we just got the note back from the EDO on that and the staff and we've not -- in the reconciliation process, we're actually going to go over at this meeting.

But, they have basically accepted the idea of adding a criterion in this area and considering the full facility.

We haven't seen the revised paper that is the paper you're going to see.

COMMISSIONER BURNS: Yes.

DR. CORRADINI: But, my anticipation is they'll follow through on that. And, we think it's near completion.

So, we'll just simply assess that when it comes back and we see the added criterion. The thought process is, is that with the added criterion, we'll just wait for the safety analysis process under Chapter 15 and see how NuScale does the analysis and how staff's safety evaluation of it.

But, at least, as far as we can see, staff is okay with our suggestions.

COMMISSIONER BURNS: Okay, good.

One other area with respect to NuScale, the letter that came back on, I think, GCD-27 issue noted that some members had reservations about the exemption.

I think this focused on, and again, I'm not the technical guy, I'm the lawyer, so forgive me on some of this.

But, I think the letter discussed the view that re-criticality beyond the short time span of what is currently allowed should not be tolerated under any circumstance.

And, is there under the current circumstances for existing currently licensed reactors, are there circumstances in which we allow --

DR. CORRADINI: Yes.

COMMISSIONER BURNS: -- re-criticality?

And, how does this NuScale scenario differ from there?

DR. CORRADINI: Okay, so, I'll try parts of this and then I'll get nudged by my colleagues if I stray.

COMMISSIONER BURNS: Okay.

DR. CORRADINI: So, under -- I mean, the one example that immediately pops in my head under current reactors is main streamline break.

I can get into a situation where I essentially have a quick cooling event.

COMMISSIONER BURNS: Okay.

DR. CORRADINI: And, under certain conditions of fuel loading, I can essentially become re-critical, and that's allowed for the short-term. Okay? Short's not defined, but we're talking -- we'll say of the order of minutes to --

COMMISSIONER BURNS: Yes.

DR. CORRADINI: -- okay, less than an hour.

COMMISSIONER BURNS: Okay.

DR. CORRADINI: In this scenario, under the -- in this situation, with this design under Chapter 15 assumptions, as I kind of went through in terms of essentially no -- only safety-related equipment can be allowed to operate, consider single failure criterion, loss of all offsite power.

That, essentially, disables, based on assumption, their non-safety grade boron injection system. So, given that they're late in the cycle, given that the low temperature, you would have a return to power and be a modest amount.

But, nonetheless, a return to power and you'd be not subcritical. And, they cannot take credit for their boron injection system.

So, that's what led the staff to say they cannot, under their interpretation of GDC-27, allow for without an exemption request.

COMMISSIONER BURNS: Okay.

DR. CORRADINI: Now, after that point, we, the Committee, has not seen any analysis of the details of that. We've heard from both staff and from the applicant that there's various, I'll call possibilities and sequences where this can occur.

But, I think on both sides, it's a low power event. The feeling is, is, and again, I'm just going to go back to the letter, to the extent that you can show long-term cooling and removal of the heat and satisfy in the specified acceptable fuel design limits, then you should be okay.

That's the staff's criteria going into the analysis.

COMMISSIONER BURNS: Okay, okay, good.

DR. CORRADINI: I'm going to look to other members to -- because there were members that felt that, under all circumstances, it doesn't matter, it's got to be subcritical.

COMMISSIONER BURNS: Oh, okay, all right, thanks.

And, I'll move on to John Stetkar here.

And, one of the discussions on the Reg Guide 1.174, the -- you talk about the Committee's recommendations regarding future revisions, including consideration of extending the guidance to new reactors, or I guess, advanced reactors, we don't have that dichotomy in some respects.

If -- are there any general principles or general criteria you think the staff might follow in considering future changes to address that new set of reactors or the advanced reactors?

Given what, you know, part of the pitch we're getting is the assumably, presumably lower risk profile for them?

MR. STETKAR: I think that, and we've actually written on this a few years ago in the context of reactor oversight process for new

reactors.

The basic principles of risk informed decision making should read, in my opinion, should remain unchanged. They're fundamental principles, so there's nothing that's unique to a new reactor.

The difference is that, if you look at the risk, I don't want to call them acceptance criteria, if you're familiar with the Reg Guide, there are two figures in the Reg Guide that look at change in core damage frequency versus absolute core damage frequency and change in large early release frequency as a function of large early release frequency.

And, if you're within certain margins, you're allowed a larger margin if you have a lower core damage frequency. If you have a higher core damage frequency, you're allowed less margin.

Those criteria, those, not criteria, were developed based on an understanding of kind of the risk of currently operating reactors.

So, for example, they don't extend to very low absolute frequencies and it's not clear how you would extrapolate those margins to new plants that have very low projected core damage frequencies or large release frequencies.

So, the primary impetus from our recommendation is to get the staff to think down in those smaller regimes. And, in fact, we've already heard from -- we've written a letter on this -- from NuScale where they're proposing certain criteria using Reg Guide 1.174 --

COMMISSIONER BURNS: Okay, okay, yes.

MR. STETKAR: -- as a basis for what are their accepted marginal criteria down in very low core damage frequency ranges?

So, it's an area that's ripe as we come into new reactor

designs. We've seen experience from NuScale, we've seen experience from some of the existing completed design certifications where different applicants have applied different interpretations of what those marginal criteria may mean.

And, if you're not careful, you're going to get into a situation where you'll have individual assessments based on ad hoc reviews on a case by case basis.

So, our recommendation is focused in that way. You get the staff and the industry thinking about exactly how those margins will be extrapolated to very low frequency areas.

COMMISSIONER BURNS: Okay, and thank you, that's helpful.

I don't have any particular questions on the Northwest Medical Isotopes. We are, as a body, we have it -- we had our mandatory hearing that, obviously, took into account staff testimony, applicant testimony, and the ACRS considerations before us. But, I do appreciate the Committee's work on that.

I think it's interesting, we mentioned it this week since the NRU reactor up in Canada, I think, closed down over the weekend or just early this week. So, the issue, and I think I've mentioned before when I was at OECD, this whole question on, you know, the -- on isotopes, you know, availability across the world for medical applications. It's an important one.

DR. POWERS: It's an exciting area.

COMMISSIONER BURNS: Yes.

DR. POWERS: And, just surprises you how ubiquitous the use of this isotope is for --

COMMISSIONER BURNS: Yes.

DR. POWERS: -- medical imaging.

And, here, you have a proposal for doing it, interesting and --

COMMISSIONER BURNS: Yes.

DR. POWERS: -- imaginative, cleverly done. But, they're a long ways away from a finalized design, but it looks promising to us and it can be done safely.

COMMISSIONER BURNS: Thank you, Dr. Powers.

And, if I could, with my colleague's indulgence, I just want to ask Dr. Rempe, I appreciate the report.

I know, you know, this is a first shot in terms of trying to do a refined report. Were there any sort of lessons learned or particular challenges you all had in this different formatting?

Obviously, the first time you do anything like this, you're trying to breakaway but any sort of insights from the work of coming up with this version?

DR. REMPE: Well, these are my comments, not --

COMMISSIONER BURNS: Sure, sure.

DR. REMPE: -- discussed it as a Committee.

COMMISSIONER BURNS: That's fine.

DR. REMPE: But, from my perspective, I think it was useful because more of the ACRS members became knowledgeable about the research.

COMMISSIONER BURNS: Oh, good.

DR. REMPE: It was more a consensus comments and

recommendations. And, I think, again, it's not -- I've been on the Committee now almost eight years, but I think it's more helpful for Committee members to learn about that research and do this more as a collegial body.

I also, I didn't have -- I was afraid I'd run out of time, but I really think we should thank the staff of RES. They were willing to come meet with us and have frank discussions about their research. And, I think that that's something that's necessary for this approach to work.

COMMISSIONER BURNS: Great, thank you.

Well, again, I thank Dr. Powers and John Stetkar for their service on the Committee and appreciate all the work that you've done as well as your colleagues in the presentation -- discussing the presentations today.

Chairman?

CHAIRMAN SVINICKI: Well, thank you.

I will go next. And, again, I appreciate all the presentations and letter reports that have been produced. I will focus, I think, on the presentations that have been given here today.

I'll begin with the NuScale exemption request. I -- this is a little bit of a variation on what my colleague had talked about.

He did talk about the statement in the letter report that some of the members had serious reservations about granting an exemption and felt that it shouldn't really be tolerated under any circumstances.

But, I would also note that the letter report itself, in the discussion section, states that it's been recognized for some time now that exemptions to the current general design criteria may be needed as design innovations are proposed based on improved knowledge and decades of reactor operating experience.

Such exemptions must be possible if reactor technology is to advance.

So, of course, I reviewed the letter report in light of the specific matter which is the NuScale particular exemption request. But, it's hard not to reflect more broadly on both the NuScale design aspects of design innovation and novelty that it presents in addition to the exemption request.

And then, to pivot more broadly to truly advanced reactors. And, we make this distinction that, in comparison to some of what is contemplated in truly advanced reactor space, the NuScale design is actually a bit mundane and humdrum and rather conventional in light of what NRC may have to confront in the future.

I have read the staff's response to the ACRS comments, but I find the additional views of ACRS Member Dimitrijevic having a closer alignment, I think, with where I am on this. And, I think that she cautions us with some peril about approaches to innovation and the technology.

And, actually, pulling way back reflecting on her views, the letter report and, broadly, the advanced reactor space where the Commission has constant engagement with members of Congress, with policymakers, broadly, those looking at the energy future of the United States.

I encounter, and I think my colleagues do as well, often concerns about NRC's ability to pivot appropriately from some of the paradigms of large light water reactors and the very, very comfortable body of knowledge that we've grown up around that and apply our nuclear safety and security paradigms to what is likely to come before us in advanced reactor space.

And, I thought that Member Dimitrijevic was cautioning us

about that, to the effect, she didn't have a dissenting view, she just had additional comments. But, I shared her cautions and concerns and not her view, but my own, as I thought about all of this was, and thought about Dr. Powers and Mr. Stetkar leaving the Committee.

And so, there are Committee members of long service that I've engaged with over the course of my time on the Commission made me wonder about your predecessors going back to the Atomic Energy Commission, and if they had held to some of the paradigms that I think are reflected in the members who say, no exemption from a GDC is ever appropriate.

If they had held that view, I question whether the United States would ever have had a nuclear power program.

Because, the body of knowledge at the time was such that they had to seek the fundamental levels of confidence that would allow us to be assured of the safety of the American public.

But, I don't think that they had the luxury of continuing to tack down all the tail end curves of risk that we, I think, have grown accustomed because we have been regulating for some decades now large light water reactors and its technology that we've become so familiar with.

So, I caution us along those lines. I think it's important to remember, if had been the NRC staff, I might have resisted your recommendations and it doesn't matter, because they've taken a view. But, I, and has other members of the Commission have to -- I confront --

This is the one that's developed a little folklore and I'm not a car person, so I might get it wrong.

But, it is, you know, I think NRC is going to require that

Teslas, you have catalytic converters or carburetors or whatever component of vehicles today that's not relevant to Teslas. You pick your flavor, we get variations on that.

And, where the staff is demonstrating that they are not going to require Teslas to have things not relevant to Teslas, I think that that is a needed approach that I'm afraid that the ACRS advice kind of beats them back from exhibiting that kind of openness to innovation in science and technology which is imperative if the country is to have nuclear going forward.

So, that's my comment on that.

Dr. Powers talked about how exotic the Northwest Medical Isotopes, that and also the SHINE technology the staff, the NRC staff had to exhibit a lot of applied approaches of the regulatory framework.

And, you know, risk informing has been described to me, I don't know how you all talk about it and risk is not my -- really my background or my resume, but it's kind of this set of questions. It is, what can go wrong? How likely is it? And, what are the consequences if does happen?

I mean, I don't know, we've got all kinds of elaborate expertise around it, but at bottom, those are the sets of questions that the staff has to answer, whether it be for Northwest Medical Isotopes or NuScale or for truly exotic things to come.

And so, I appreciate that work that's been done on the updating of 1.174. I think we continue to move forward.

But, the staff has some uncomfortable paradigms to shift going forward. And, I think that, you know, the Committee's role is the Committee's role. But, maybe if you were to look deep back into the ACRS's history, I think that your predecessors might have had to confront what you

and ACRS members going into the future might have to confront which is, how do we find the elusive sweet spots of confidence and risk informing ourselves that allow technology to be innovated and advanced going forward?

So, Dr. Rempe, I'll just conclude by noting that you -- one of the conclusions in the research review was that consequence analysis should be a core competency.

I don't know if imbedded in that is this kind of a euphemistic way that the Committee shares some of these concerns about answering the third question of the risk triplet which is, how significant is it if it occurs? I don't if that was what was intended by consequence analysis as the core competency. Perhaps you could give me some feedback on that.

DR. REMPE: Absolutely. I'm referring to our ability to use the MACCS Code to look at the effects of a radiological release, health and safety doses, et cetera.

CHAIRMAN SVINICKI: Okay, thank you.

And then, broadly, I do appreciate that the Committee took on modifying the format of the research review.

After I made comments about that in 2016 and then engaged with you directly when the Committee decided it had an interest in looking at the format of the much more detailed report that had previously been written.

I was -- I met with -- well, he's here today, our current Director of Nuclear Regulatory Research, Mike Webber. And, he reminded me that another audience for the ACRS's research review has always been the Research staff and the NRC staff more broadly, that they take in the insights of the ACRS in the more detailed report had provided.

Are you confident that, in your engagement with the Research staff you haven't lost their ability to take away benefit from the Committee's broader insights, even if they're not necessarily captured in the report itself?

DR. REMPE: So, I won't know until we hear back from the staff with their official comments to the report.

But, I personally believe that a lot of that 80-page document was boilerplate. I don't think the staff needs to have us describe what their research projects are.

And so, I think we still do provide the recommendations that were imbedded in that report. But, again, we'll hear back from the staff. It was a first year -- or two year effort. It's the first time we've tried it.

And, I believe actually when I met with Commissioner Baran, he said, you know, don't expect to get it right the first time. So, if we hear some comments otherwise, we'll adjust accordingly.

CHAIRMAN SVINICKI: Okay, thank you.

Chairman Corradini, did you want to say something about risk?

DR. CORRADINI: No, I mean, you were --

CHAIRMAN SVINICKI: There's a lot of byplay between you and Mr. Stetkar.

DR. CORRADINI: You -- I was -- I didn't know if there was a question coming in there. But, can I interject one piece of personal opinion?

You said something about the non-light water reactors in the NuScale. I do think there's a principle that we've been asking NuScale, and we're probably going to ask, if we ever get around to these new advancing, is

we're looking for either a combination of integral testing. And, it's in -- actually, it's in the Research report. Joy made a good point of it in the Research report.

There's going to be times when there's going to be a lack of data. We've got to get that experimental data.

Now, the experimental data doesn't have to be NRC's directed data, but it's got to be there so that we're very clear that with these advanced designs, whether it be the, I'll use your words, I liked them, the humdrum NuScale version or the, we'll call them the supercharged non-light water reactor versions, you've got to get the experimental data that validates what we expect to be the required performance.

And, that's probably one of the things that's -- I don't think Joy mentioned in her discussion, but it's definitely in the Research report, that it's important.

CHAIRMAN SVINICKI: I appreciate that. And, it is good we talked about the need for those documents.

DR. CORRADINI: But, meant you didn't do it orally here, but it's in the report.

DR. REMPE: Actually, it was mentioned today.

(LAUGHTER)

DR. REMPE: It's under DE discussion, yes.

CHAIRMAN SVINICKI: Okay, well, I appreciate that. And, I think, in future engagements between the Commission and the ACRS and the ACRS and the staff, there are a lot of questions being asked about how much independent research does the NRC have to actually conduct going forward?

I think that that's -- there's' broad uncertainty about the time that it would take, the necessity of it and the -- just the overall scope of what NRC will want to redo independently when it comes to that.

And then, a prong of that is the development of NRC Codes by themselves as opposed to just doing validation work with Codes that are utilized by others.

So, I think not a topic for today, but I think that that will be an active area for the ACRS to look at the staff to develop approaches and then the Commission to decide its level of comfort with that.

DR. CORRADINI: It's funny you mention that, I was going to -- I didn't say that earlier, but I think you're point here is important which is that, if there are new advances by industry or the DOE in some collaborative way, I think we've got to look at them, whether it be in thermal hydraulics or in reactor physics, et cetera, so that we understand if there's some advance, then we have to understand how good it is and how it can be applied.

CHAIRMAN SVINICKI: Okay, thank you.

And, with the indulgence of my colleagues, after Commissioner Baran gives his remarks, I would like to request that Member Stetkar and Member Powers share any thought that they would like to share, and I might ask you to think along the lines of, is there any caution that you would you would offer the broad enterprise going forward as you leave your service on the ACRS?

Thank you.

Commissioner Baran?

COMMISSIONER BARAN: Thanks.

Well, I think the discussion so far on the NuScale reactivity

control exemption request has been interesting. I have a few follow up questions on that.

Taking a step back, the issue, as I understand it, is that under certain design basis event scenarios, namely there's a loss of offsite power and you have a single stuck control rod that fails to insert.

The reactor would shut down safely, but then return to power potentially for an uncertain period of time so that you could have a situation where, under those circumstances, the reactor wouldn't stay completely turned off. Is that essentially the issue?

DR. CORRADINI: Under Chapter 15 assumptions, that possibility does exist, yes.

COMMISSIONER BARAN: And, the Chairman talked a little bit about the need to, particularly in advanced reactors, there's a whole look at the GDC and what are the principle design criteria that would make sense in a non-light water reactor context versus what we had with the light water reactors.

Here, I'm not sure I really see that as being the situation because there's nothing about the NuScale design that would make reactivity control unimportant, is there? I mean, that's still a relevant factor for a NuScale design, the general design criteria generally?

DR. CORRADINI: I guess this is -- I want to stay with the letter report, so I'm going to simply state it this way which is to the extent that you can remove decay heat or thermal power and maintain core coolability or cool -- core cooling, that's the -- that's essentially the criteria the staff is addressing in terms of their criteria comparing it to the NuScale design.

COMMISSIONER BARAN: Okay. And, there was a --

you had some discussion with Commissioner Burns about cases where there have been -- the staff's found acceptable short-term in the range of minutes, less than an hour, reactivity.

Are there any cases where NRC has licensed a power reactor that might not remain subcritical beyond the short-term? Is this -- is that aspect of it new in the NRC experience?

DR. CORRADINI: I'm not familiar of anything.

COMMISSIONER BARAN: And, the Committee's letter said that basically, the reactor, in this scenario if it were to occur, would remain critical until an alternate means of reactivity controls actuated.

And, I -- is that likely that there would be operator actions to actuate the non-safety related boron injection system that's --

DR. CORRADINI: It wouldn't require -- if I might just --

COMMISSIONER BARAN: Yes.

DR. CORRADINI: -- clarify.

So, under Chapter 15 assumptions, you can't take credit for that.

COMMISSIONER BARAN: Right.

DR. CORRADINI: But, automatically, you would essentially initiate that, assuming it was available.

COMMISSIONER BARAN: Okay. So, this is a case in which potentially a conservatism in the way you can take credit. You couldn't take credit for it because it's not safety related. But, we think that's the thing that they would turn to immediately in this situation?

DR. CORRADINI: He's jumping up and down.

COMMISSIONER BARAN: He wants to get in.

DR. POWERS: Yes, I may have a couple of things here.

Absolutely, you're running into a -- you set up some very conservative requirements for your Chapter 15 analysis, and you're finding you're running afoul of those. They're forcing you into a very conservative position.

On the other hand, the licensee has gotten himself into this position because he doesn't want to make his boron injection system safety grade.

I mean, there's a conflict between advertising and conservatism here.

It's --

COMMISSIONER BARAN: So, if it were safety related, you could take credit --

DR. POWERS: -- kind of silly to get into --

COMMISSIONER BARAN: -- for it and you wouldn't have this issue?

DR. POWERS: Yes, and certainly, we have many times said that when the Chapter 15 analysis forces us into a very conservative position and we are required to violate some rules for a short period of time and not very badly, that's okay because they're very conservative. We've done on several occasions.

Here, I think it's one that -- it's, you know, people want to make -- say a plant is passive and so they absolutely refuse to make something safety grade because they want it to be passive.

Well, that's silly and -- even there can be silliness on both sides of this equation is my point.

COMMISSIONER BARAN: One of the Committee's recommendations was to take a look at the incremental risk of all of this.

Do we, at this point knowing what we know today, does the Committee or does the NRC staff have a good sense of what the probability of this type of scenario is?

DR. CORRADINI: So, we -- so, the Director answers no.

COMMISSIONER BARAN: Okay.

DR. CORRADINI: For us, because we have not heard that -- we haven't seen that analysis. That's the direct answer.

Elaborating on that, we've already started asking NuScale to come in to give us a detailed discussion of their whole system because we don't really know what, in detail, what the system is and how it responds.

And, we got a short snow curtailed meeting on the PRA where we started getting some estimates.

But, I'll be very frank with you, we're early in the game and so we've yet to completely understand the system and we've yet, at all, to know the details of the PRA.

But, that's why, if I might just go back to the letter, that's why some of us felt it's important that there ought be a risk calculation, an incremental risk decision to make sure that, if we allow this, it's down in the region, as John was saying, of low frequency. All right? As well as low consequence for the whole facility.

COMMISSIONER BARAN: Is there -- I think it's the case that there are some domestic and international operating experience of single stuck rods not inserting because of an earthquake or an equipment issue. And, you would expect that that would feed into this analysis --

DR. POWERS: It happens a lot.

COMMISSIONER BARAN: -- and probability of that.

DR. POWERS: I mean, if you look over the integrated history, it has happened. And, the problem with looking at any single sequence from a risk perspective, any single sequence, very low risk significance.

You have to look at the integration of your design and what you're trying to achieve. Chapter 15 and risk are kind of orthogonal on their nature.

But, you've got to look at what does that give you is a boundary condition on your risk assessment by having these divergent capabilities.

Because, when you do the risk assessment, now you're going to give them credit for non-safety functioning boron injection system with some prescribed reliability on it.

COMMISSIONER BARAN: Did you want to add something or you just standing right -- okay.

DR. CORRADINI: We could go on about this, you're reliving the discussion into the letter. So, good.

COMMISSIONER BARAN: Well, let me ask then, the one last part of it that I wanted to hear.

Either we've had -- the letter refers to some of the members of the Committee who have the view that they have serious reservations about this.

Does someone want to -- we've been talking about these folks and their views, but I'd be interested in hearing from someone who has

that view or to articulate that point of view and explain why --

DR. POWERS: Well, I'm not one of the adamants. I was actually the author of the same -- of the sentence that says we have to allow deviations from the general design criteria.

But, I understand where they're coming from is that, since the caveman ages of nuclear, shutdown means shutdown. It does not mean kind of shutdown.

And, the problem is, the colligative processes of nucleonics are just very, very hazardous if they get out of hand.

And so, yes, we -- you're more tolerant of, okay, it's hot and I can extract heat and things like that, but the fact that we're having chain reactions going on here is anathema to everybody who's been educated in nuclear engineering from day one. That's what you learn, shutdown means shutdown with margin.

And, that's the point that the people that I would say are adamant on this. It's bred to the bone when you learn about nucleonics because of the threshold kind of nature of a nuclear -- sustained nuclear fission is one that you, you know, just never want to mess with that. And, when you do --

On the other hand, if you take an ironclad -- when the general design criteria were set up, our knowledge base was much less than what it is now. And so, they took some conservative positions because we didn't know.

We didn't even know what kind of reactors we ought to be building. We tried a lot of different designs. Some you'd shake your head at now -- and I shake my head at them all the time now anyway.

But, if you deny progress by edict, you'll never have any progress.

DR. CORRADINI: I think he characterized it well.

COMMISSIONER BARAN: The whole discussion back at -- both sides.

(LAUGHTER)

COMMISSIONER BARAN: Does anyone else want to add anything? I mean, anyone think they can top that?

Yes, please, you don't have to top it, you can just share your view.

MR. BROWN: Hi, I'm Member Brown. I happen to be probably the most vocal dissident on this particular subject in our meetings.

My background, if you don't remember, which you probably don't, I was in the naval nuclear program for 35 years. And, re-criticality was anathema to us for any shipboard operation or concern that we had to deal with as well as our prototypes, and we had nine or ten prototypes in service training for decades.

So, we came down to -- I come down largely on the side of, there are some principles that you have to set a pretty high standard to vary from or to deviate from.

My background, other than just the Naval program was in reactor instrumentation and control as well as well as all the safety analysis I was responsible for for 22 years as well as the earlier years on my specific projects.

So, I was deeply involved with not only the materials, the reactor engineering, the physics and safeguards aspects of those plants.

And, re-criticality and one other one, largely the containment type issues, were very, very seriously high level principles for us.

Based on my I&C world and all the analysis work that I was involved in, I also developed a healthy respect for the fact that if you did not have exceptions, you wouldn't need rules.

It's a matter of how you vary from those rules and the information you develop and require to make that decision of what is critical to the path that you proceed down.

In this particular circumstance, the probabilities are low. It requires a number of different things to be in place in order to allow this power to continue for not just minutes or an hour, but for hours or days in circumstances.

We've always had the decay -- deal with decay heat. I mean, that starts off at, you know, 6 or 7 percent power, somewhere in that ball park, gets to a fairly low level after 10 or 11, 12 days, whatever it is, but it's always there for a long time.

This seems to be now we are putting ourselves in a position of saying, a low power return to critical for days and days in addition to the decay heat we deal with, now puts the operators in a condition that they don't have control over what they're dealing with, the heat.

So, you are dependent on now long-term ability to maintain systems that aren't safety grade in order to put -- to proceed.

This is the forum in which that decision is the right place to be made. It shouldn't be made at our level or the staff level, it has to be made at the Commission level. And, that's what all this angst is about.

So, I just -- the idea, to me, was principle and I think that

principle should, for re-criticality, short periods, you can't avoid that, it's just -- I mean, we had that -- we had to face that issue with our plants that were little burps that you had to deal with as you first shutdown in any accident scenario.

But, they were literally seconds to minutes and then it would then -- you did require operator intervention to do it.

So, my recommendation is to think long and hard before you -- I fully agree with the Chairman's point on Tesla and putting catalytic converters -- I love the analogy, it was very, very appropriate. That's totally out of whack and we don't want to get in that condition.

But, I still think this principle of re-criticality is a very, very critical one to start thinking very thoughtfully about how we proceed with it. And so, that's about all I would have to say.

Thank you.

COMMISSIONER BARAN: It's a good way to conclude this discussion on that. Thank you very much.

CHAIRMAN SVINICKI: Well, again, I -- that is a great discussion and I'm very glad that Member Brown came to the microphone so we have insights into your deliberative process.

We are a deliberative body as well. And so, I view it as evidence of a very good culture of batting back these perspectives on your Committee.

And, that only raises my confidence in your letter reports because, if that is the kind of broad, philosophical engagement going on behind them, then they are -- they have a strong foundation.

My colleague stated that he wasn't the technical guy, I think he said he was the lawyer. Well, having been trained as a nuclear engineer,

I understand that nuclear is not a religion and often I have to remind people of that. It's not a theology, it's a technology.

As someone who was trained in that technology, to the extent there are sacred things in nuclear. Criticality is one of them and I acknowledge that. So, I acknowledge that this is something that needs to rest heavily on the shoulders of the members of the Commission to either affirm the staff's approach or not.

And, it's worth thinking long and hard about. I agree with that as well. So, I appreciate that we've had an opportunity in this meeting to more fully characterize that.

I do want to return to see if either of the members who are concluding their term of service want to take me up on an opportunity.

I will just say, if Dr. Powers is coming to the microphone, I've already discerned that you cautioned us against silliness. I think that was something that you've already indicated, just said there's the tendency for silliness on either side of a question. And, you cautioned against that.

But, I will just say that I'm a little bit familiar with your resume. I do appreciate your long service on the ACRS. I knew the day would come when the current Chairman of the ACRS at the time would inform me that Dr. Powers' family had decided it was time for him to spend more family time.

And he would be tapped on the shoulder and it would be suggested to him -- no, okay. So, I'm getting a big no, I either wasn't supposed to admit that they told me that or it's not true.

But, either way, I do, you know, you have engaged in the course of your time, including as a student with many of the kind of the lions

of nuclear science and the legendary figures that makes you a very legendary figure and a lion of this science by association, if nothing else, but also by your own accomplishment.

So, in all -- and I know I've always enjoyed teasing you about this and that, but it just makes me feel kind of full of myself to be able to tease someone with all of the gravitas that you bring to nuclear science and technology.

But, we did know this day would come, as sad as it is, so if there are any, either serious or glib parting of thoughts you'd like to make, I certainly welcome you to do that.

DR. POWERS: Well, I'm a little surprised you haven't gotten a call from my wife insisting that you reappoint me. So, I think she enjoys the monthly respite from having me around a little bit.

On the other hand, there does come a time when you need to allow younger people to come and see if they can do a better job than all the mistakes I have made.

You pose the question, are there any things that I think I would communicate to you for the future. And, I guess I do have a concern that we are not taking aggressive enough use of this marvelous risk technology that has emerged.

And, that we are settling back to what we always feared is that we would stack risk analysis on top of the deterministic analysis rather than allowing it to supplant some of the deterministic analysis.

And, I also fear that you've written a position that says, gee, we ought to use risk in other parts of the regulatory world than just reactors. You have to be careful about that because many, many of your licensees are

in no position to do risk assessment they've had.

But, some areas, particularly, in the waste areas and whatnot are in a position to take advantage of risk. And, we ought to risk inform our regulations in those areas.

The problem is, it can't be done because you have not pushed your staff to generate the necessary risk information that you have to have to risk inform things.

Remember, the concept of risk emerged probably in 1974, '76, but before we could use it, we spent two decades developing a body of risk information.

We did it first by the NRC study of five representative reactors. And then we asked all the licensees to examine all of their reactors and give us another body of risk information before we could make any real use of it, before we could write Reg Guide 1.174, before we could make the ROP. We had to have that body of risk information.

Well, you're not giving to tools that kind of body of information to your organizations outside the reactor community to follow up on your proclamation that they ought to use risk information where ever they can.

And, we've just -- just on Wednesday, we met with some of the staff and saw how much of a handicap that it was for them to move into the risk information.

So, I guess the caution I'm saying is, don't let this evolution in being able to use risk information, as appropriate, a flag, that don't let it become an add-on on top of the deterministic only.

And, don't say go use risk information elsewhere in the Reg

Guide and not give them the tools that they need in order to do that risk information. Because it will be very different. They can't come borrow the reactor databases and run over and do them in every case.

They can in some and, in fact, Mr. Stetkar pointed out to the staff, that the wind and tornados and falling aircraft, don't know what they're falling on or slamming into, whether it's a facility, a repository or the reactor and you can use it. But, by and large, they can't. And, by and large, they need a -- it takes a huge body of experiential information to bring any new technology to bear.

CHAIRMAN SVINICKI: Thank you for those insights.

Mr. Stetkar?

MR. STETKAR: I'm tempted to say what he said. But --

(LAUGHTER)

MR. STETKAR: -- no, it's amazing, I'm sitting here sort of scribbling down notes and I think he read them.

One thing that --

DR. POWERS: After all these years, we're mentally connected.

(LAUGHTER)

MR. STETKAR: We've -- and believe me, that's scary on so many levels.

(LAUGHTER)

MR. STETKAR: You don't even want to go there.

I certainly echo everything that Dana said about consideration of risk going forward.

Thinking about it, one thing I'd like to add is that, I don't know

how many years ago it was, the paper that elaborated the differences between a structuralist and a rationalist approach to life, I think it was '99.

We had a, I think it was an ACRS fellow who's the primary author of it.

It's a very interesting paper.

DR. POWERS: No, it was the product of an ACRS retreat held at MIT.

MR. STETKAR: Was it?

DR. POWERS: And, Dr. Apostolakis and I went nose to nose.

MR. STETKAR: I think the thought that I was going to leave you with is, and it's pertinent to a lot of the discussion that we had today on NuScale and other technologies is that, traditionally, in my opinion, the NRC and the industry, and especially if we go way back, as the Chairman mentioned, to the early days of nuclear power, developed a very structuralist viewpoint of regulation.

You established criteria that you believed were conservative. You ensured that applicants design, constructed and operated their facilities according to those criteria and, ipso facto, they were safe.

We've developed now a technology risk assessment technology that challenges a broader spectrum of scenarios, a broad spectrum of conditions. What can happen? Not, this shall happen with these predefined no offsite power, predefined no operator actions, predefined single failure and no double failure.

And, we've learned a lot from that process. That's more of the rationalist thinking in terms of asking a broader spectrum of what can

happen? How likely is it? And, what are the consequences?

Structuralist said, as long as you follow the rules, it isn't going to happen.

Now, going forward, I believe that following that rationalist approach using risk information more extensively, provides the opportunity for you to look systematically at those old notions of criteria, do you meet in a specific set of criteria and, if you don't, you're not safe, if you do, you are safe.

And, it gives you that opportunity to move forward in a more informed position. It is -- it's not an ad hoc position, it's an informed position because you're challenged to systematically examine for a particular design and even for a particular site what can happen and what are the sources of risk and deal with those in an informed manner.

That doesn't mean that risk is the answer to everything because risk, as we know, attempts to quantify uncertainties. In many cases, those uncertainties are very large and, in many cases, it's very difficult to even adequately try to assess the range of uncertainty.

People have brought up the glib term of the unknown unknowns.

So, there is still, I believe, in the regulations and the staff reviews a place for those, you call them deterministic, I'll call them structuralist backstops. I tend to think of them in terms of defense in depth considerations, but not necessarily, and Dana mentioned it, as risk is an adjunct to that structuralist viewpoint.

I'd flip it around. I'd say, take the rationalist standpoint and make sure that you still maintain an awareness of those structuralist requirements in areas, especially where you have very, very large

uncertainties and where the risk, both frequency and consequences, could be substantial.

Not where the risk where you have confidence that it's very small, we don't need to make something extremely small much smaller, as long as we have confidence that it is, indeed, small.

That's going forward, I'd just try to challenge, in particular, the Commission, from a top down to try to drive the staff that way. I think it's a way of getting past a lot of these -- the types of discussions we were having today about, you know.

CHAIRMAN SVINICKI: Okay, well, thank you both for your long service.

I thank all the members of the Committee for their work.

And, we are adjourned.

(Whereupon, the above-entitled matter went off the record at 11:39 a.m.)