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BRIEFING ON VENTING SYSTEMS FOR MARK I AND II CONTAINMENTS

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TRANSCRIPT OF PROCEEDINGS

Public Meeting

Before the U.S. Nuclear Regulatory Commission:

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Kristine L. Svinicki, Commissioner

George Apostolakis, Commissioner

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APPEARANCES

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P R O C E E D I N G S

CHAIRMAN MACFARLANE: Everybody settled? Then we will get started. So the Commission meets today to discuss proposed additional requirements for containment venting systems for boiling water reactors with Mark I and Mark II containment designs. We're here, in large part, because of the accident at Fukushima. And this accident highlighted the challenges that boiling water reactors with Mark I and Mark II containments can face during severe accidents due to overpressure and hydrogen build-up. The NRC staff has presented a paper to the Commission proposing options for additional requirements, including making containment vents capable of functioning during severe accidents, adding filters to the vents, and conducting additional research to enact a severe accident confinement strategy. In its paper, the NRC staff recommended the Commission approve the addition of a filtered containment venting system. Before we hear from the NRC staff on this topic, we'll first hear from a panel of external folks representing the nuclear industry, the Electric Power Research Institute, the Union of Concerned Scientists, and the Canadian Nuclear Safety Commission. Before we begin, let me ask if any of my fellow Commissioners would like to make any opening remarks?

Okay, then we will move right on to the external panelists. So we're going to get started with Maria Korsnick, who is chief nuclear officer and chief operating officer of Constellation Energy Nuclear Group. Maria.

MARIA KORSNICK: Thank you. Madam Chairman and Commissioners, I want to thank you for the opportunity to discuss the industry's position on venting for Mark I and Mark II containments today. I'd like to start by reflecting on the path that we took to get here. The staff was asked to evaluate

the value of adding a filter to the containment vent. We redefined the question and asked ourselves, "What's the best way to protect the environment and prevent land contamination?" This took us down a path of managing severe accidents. We commissioned a technical team to do this work, and you'll hear the results today from Neil Wilmshurst. The study was comprehensive, evaluated numerous cases, and received positive reviews from the ACRS. My purpose here today is to discuss proper management of severe accidents, because it's at the very heart of preventing land contamination. I would like to note that we see a number of regulatory policy and technical issues in SECY-12-0157. I don't intend to use our time today to go through these; however, we will provide this feedback in a letter within two weeks. Slide two, please.

The nuclear energy industry fully supports minimizing the potential for radiological release and the associated land contamination resulting from a very low-probability severe-core-damage accident. I'm on the previous slide, please. While the industry efforts place significant emphasis on the prevention of core damage, we also looked at ways to reduce the off-site consequences of a severe accident. Our analysis has demonstrated that a performance-based approach to filtration provides the greatest overall improvement in plant safety with sufficient filtration. And we believe that we can implement this consistent with the schedule for Option 3. The industry approach has the advantage of retaining the filtered radionuclides in containment. The desire is to prevent land contamination. If you jump right to an engineered external filter, you miss some of the important actions that we need to focus on and prioritize for managing a severe accident. Next slide.

This graphic demonstrates the large improvement in safety margin at our plants based on lessons learned from the Fukushima accident. The best way to prevent land contamination is to prevent fuel damage. We have layers of protection to do just that, and have added FLEX as an additional strategy. Next slide.

The EPRI evaluation, along with our tabletop pilot exercise on filtering strategies, reinforced that the overarching need to maintain the three primary barriers to fission product release. In the unlikely event that a severe core damage accident develops, the most important strategy is to manage the containment system as that final barrier. Industry evaluations have shown that the addition of a passive filter, without proper management of the containment, is not successful. Next slide.

Managing containment during a fuel damage event is the single, most important mitigating strategy. By properly addressing core debris cooling, and maximizing filtration in containment, we can significantly reduce radionuclide release. Containment failure occurs when the debris is not cooled, and filters are ineffective if this occurs because the releases bypass the filter. This is a much broader issue than a discussion of filter versus no filter. We believe SECY Option 4 provides for an integrated approach and will ensure that we include managing containment as part of the solution. Next slide.

Containment management involves several strategies. Paramount is the cooling of the core debris. Without debris cooling, the containment will fail, creating these uncontrolled release paths, rendering event filter ineffective. In addition to cooling the core debris, water injection and spray into containment are very effective at filtering radionuclides while keeping them within containment.

As you see on this slide, there are passive and active components in our strategy. Next slide.

During a severe accident, the containment must be actively managed. We desire a solution that is independent of plant response; that requires no operator action; sounds like the perfect solution, but the science tells us differently. Opening the vent and leaving it open is not a good option. Our analysis shows, as the accident progresses, you go negative in pressure in the containment, which would naturally draw air into containment through the vent. This would create a combustible gas mixture and fail containment. The SECY was silent on this. The concern for operator action to manage containment pressure has also been raised. I'd like to just give you an idea of what's required. We would need to vent six to eight times in the first 24 hours, the first time being, at the earliest, five hours into the event. One of the design considerations would be an engineered pressure control system, independently powered, with sufficient power and pneumatics to operate more than 10 times, operated from a centralized location, such as the control room, with the goal to minimize operator action. Of course, we would also assume that this, too, fails, and would be able to manually operate this, as well. By controlling the containment pressure within a designated pressure band, greater time is provided for natural radionuclide removal mechanisms within containment. We all desire an ideal solution, but it needs to be an integrative one; built in to the severe accident management approach. Next slide.

We did test the feasibility of implementing the strategies outlined in the EPRI report. Using plant engineering, operational staff, as well as industry experts, we showed that the performance-based framework was successful.

These results were just finalized by the BWR owners' group in a technical report yesterday. We did identify some enhancements, and I list some of those on the next slide. For example, the proposed changes build on the FLEX program. We would be extending FLEX capability to post-core damage, where the original intention of FLEX was to prevent core damage. We would need additional connection points and additional equipment. Next slide.

The performance-based approach would call for reliable and effective filtering strategies through core debris cooling, control of containment pressure and temperature, and maximizing the inherent in-containment filtration. The broader approach is required to manage containment during a severe accident, and reduces radionuclide release. Specific criteria would be developed to define what is meant by reliable and effective, and could include such things as the ability to operate in the expected conditions, be power independent, be supported by proceduralized guidance, and have specific training requirements. It's not new technology, it doesn't require us to invent new computer codes to model it, we can accommodate uncertainties that are part of any accident analyses. Plant-specific analysis would be done, and leaves the option for plants to select an external filter as part of their strategy if an analysis warrants it. The ACRS supported this approach. Next slide.

The path forward should begin immediately. The current order for the BWR Mark I and II hardened vents should be expanded to require a severe-accident-capable vent. That order should also address both wetwell and drywell venting. We should ensure that the current FLEX designs include the capability to inject water into the containment, by way of the drywell sprays, and have connection points that are accessible outside of the reactor building. The NRC

and industry should begin developing guidance for implementing a performance-based approach under Option 4. Overall, this approach provides the greatest improvement in safety and addresses the broader issue of containment management. We believe this can be implemented within the same timeframe as an external filter option. Most importantly, it ensures the right focus for the industry and oversight provided by the NRC on the most beneficial strategy for protecting the environment. Thank you very much for this opportunity to address you today.

CHAIRMAN MACFARLANE: Thank you very much, Maria. We will move on to our next presenter. This is Preston Swafford, the chief nuclear officer from the Tennessee Valley Authority. Mr. Swafford.

PRESTON SWAFFORD: Good morning, Chairman Macfarlane and Commissioners. TVA appreciates the opportunity to come here today and speak and represent some of the initiatives that, as a member of the nuclear industry and utility and activities that Maria just outlined. I think what I'm going to do is go into a little bit of detail in our coping strategies more than some other issues, because I think it highlights the point Maria is trying to make of how you preserve the containment. But we've also, all along, been working in terms of is there a potential value add to a filter, and what that -- so we've had parallel activities going on since almost March of 2011 in this arena. So, today, I'm going to share with you some of those thoughts. Next slide.

Specifically, the Fukushima strategy that TVA put together, we convened, I think, the Monday following the Friday of the event and started immediately recognizing the impact to TVA, as well as the industry, was going to be significant, and our hearts went out to the Japanese families and the

communities affected. But we also needed, I think, to quickly drive our key strategy so we could move forward and I could start to mobilize our organization. Out of that came what eventually was the TVA FLEX initiatives that the industry has supported, and I'll speak to some of the initiatives that we, specifically, deployed. But I need you to recognize that my counterparts at other plants have been doing significant things as well; not necessarily exactly what we're doing, but there's been some robust decisions made from buying multiple fire pumpers to be able to inject into the core, to large diesel generators applied at site and things like that. For us, we're speaking specifically to TVA, but I think it'll share that the coping strategies, as we expand those periods, is hugely beneficial to keeping the core covered and keeping containment intact. And, finally, I'll speak to a few issues and events that we're doing in terms of the containment vent approach at TVA.

So our strategy: the planning began in March, like I mentioned. Three key elements that are essentially the same as the industry's, but you needed to prevent fuel damage, the containment integrity is paramount, and how are we going to effectively deal with widespread land contamination. The Three Mile Island event did not have land contamination tied to it, so this became a new and unique issue. I think, from the industry, the BWR design and the Mark I containment that was Fukushima Dai-ichi design is very similar to our Browns Ferry plant, so this hits home in our ability to effectively prevent the widespread land contamination. That's been a key initiative as a member of the industry, as well as of TVA.

Our next slide. Talking specifically in coping time. Although some of this comes out in the orders and recommendations, but I wanted to share,

specifically, what we're doing. Extending the D.C. power availability is key, the batteries. And, obviously, we started new procedures on how to shed loads and things like that to make the batteries last longer. But at TVA, we have also procured 200 KVA diesel generators that are going to be able to be directly tied to either the 480 volt bus or directly to the charger, so that -- and this will be secured in a strong, if you will, building that we have high assurance out of the floodplain, not affected by seismic, and able to handle high wind loads. Also, AC is clear, it was king. When we lost AC power in Japan, that's when major issues began to unfold. We procured 3 megawatt diesel generators; they're going to be installed in a bunker building I'll talk about in just a minute. But these are all going to give much higher assurance that the operators will be able to fully power their safety loads. Minimizing plant staff burden is a key part of this. As much of this will be hardwired if possible, but it's also going to be flexible; it'll be able to be maneuvered to different switching locations throughout the plant should one switch here be gone and another one need to be energized. And we have -- most of these materials are on site, is our strategy at TVA, so that our resources are easily unfolded and dedicated to get this implemented. So, the next page, Page 5, I've already hit this, but this clearly says that 200 KVA diesel generators will be important and our versatility in how we switch these in, I think is the key attribute to this one.

Next slide is the big diesels. We do have one for each unit, so we have, on top of, obviously, the eight diesels that are already in, if you will, hardened facilities, we're also building a bunker building capable of wind, tornadoes, floodplains, seismic, those issues are going to house these diesels and one for each unit for that additional ability. Next slide.

We've also procured 5,000 GPM Dominator pumps. These are diesel driven pumps, so they'll be stored in the bunker building. These are capable of being attached to the vessel for injection in order to drywell sprays like Maria has mentioned as a key component to keeping containment integrity in place. We have one for each unit, as well as a spare. These easily unfold from the bunker building and can be quickly aligned and used for injection. We've also been working on -- a fellow from Brown's Ferry is actually a lead in the EOP's changes, so he's been actively involved in the industry, as well as in Japan, in terms of how can we streamline our EOIs and make sure that all of this added equipment, and the burdens of that, can be practiced and implemented.

Next slide, Page 8, continues on with another issue that didn't just come out of our Fukushima team, but it also came out of Brown's Ferry's committed to converting to NFPA 805. And, in there, we found that by adding an additional motorized RCIC, or reactor core isolation cooling pump, that we can gain substantially in reduction of risk at the plant. So we've decided that not only will this provide a key injection source at the facility on top of our installed ones, but it will also improve our margins from a safety risk standpoint. These will be established in the plant and at separate areas defined in separated fire zones and seismic areas. Also being able to be powered by normal AC in the plant, but also a quick connect capability to our diesels that are Fukushima 3 megawatt diesels out in our bunker building. So the versatility brought in, again, increases our probability of getting water in containment, water in the vessel, substantially quicker and with a lot of flexibility to it. So I think the spirit of the FLEX initiative comes through in our approach of how we're building in these coping strategies. So, finally, it's diverse, it's flexible and it is designed to prevent fuel damage and

maintain containment. And our efforts in the EOI improvements will clearly help guide our operators through it.

On Page 10, I want to talk a little bit about the hardened vents. We do have a hardened wetwell vent at Brown's Ferry, but we've also made a decision that we will, and probably recommendation to the staff, as well, but we will be installing a drywell vent, hardened as well. We have one line in our vent system to handle three units. It was never designed to have simultaneous venting going on. So right now our procedure requires to kind of sequence each unit if we were to have a Dai-ichi-type event it would be an issue for our operators coordinating venting so we will separate those three vent lines, harden them, and attach the drywell vent to the wetwell vent in our design.

We have also put a footprint in for filter building. Since day one because of our goal of not having widespread contamination, wanted to have built into the design so I didn't have to go backfit anything. If we were to have to put in a filter, if dry filters or wet filters became ultimately a good decision, I wanted that built in. So we've had in parallel engineers reviewing different design functions for wet and dry. My goal to them is to try to do the best they can to get a dry system in. The wet filters designed in Europe and other places have been around for quite a while. That technology is fairly well understood. Obviously debating whether or not the values add to that, ultimately, is there or not. We have not decided at TVA one way or the other. But the part we're trying to explore is could a dry filter in a simpler application actually have some benefit and I'll call, in a second, this gap period should have some trouble installing some of your coping time strategies.

So on page 11, clearly the coping strategy implemented is key to all this, and it significantly reduces the likelihood of a severe accident. However, in a delayed or disrupted period where maybe there's a coping time delay where we've actually started to uncover the vessel but not yet had vessel integrity breakthrough, we may by blowing down to the torus, be introducing multiple different fission fragments and other types of issues. This vehicle of a dry filter for that period of time in between vessel rupture bleed through to the floor might be of value. We've not concluded one way or the other yet, so there will be analysis but there may be some additional coping time that filter might benefit us, but we have to finish that.

We've worked with vendors, we have now led a contract for some vendors to actually do the study and do the map analysis on it and actually get back to us in terms of what they think the value actually is and that amount of coping time kind of extension, if you will, that it might benefit us. If it goes all the way to the point where Maria's point was made where it gets to the floor, then I think at that point, the dry filter is probably not a value-add proposition and there's argument of whether even a wet filter might be at that point.

So to finish up, SECY, we are supporting Maria and the industry and Option 4; we think what we've been doing is actually following Option 4, as we've been going through this. But we've -- because I believe looking at the potential dry filter or wet filters, certainly a part of the analysis going forward for Option 4. And that concludes my talking points.

CHAIRMAN MACFARLANE: Okay, thank you very much. Move on to hear from Neil Wilmshurst who is vice president for nuclear at the Electric Power Research Institute. Mr. Wilmhurst.

NEIL WILMSHURST: Thank you, Madam Chairman. Madam Chairman and Commissioners, thank you for this opportunity to discuss a, I believe, significant body of work conducted by my team with the intent of informing the debate on filters and filtering strategies. So moving on to slide two. The results have been touched on in early presentations. My team has been working on severe accident management guidelines, EPRI produces the technical basis for severe accident management guidelines which are then taken by the various technology owners groups and turned into the severe accident management guidelines on the plants.

And concurrent with this work, the question of land contamination, filtering, filtering strategies came up. And so what we did, we actually changed the question. The question that was being talked around was “Are filters good, are filters bad?” We changed the question to “in the context of severe accident management, what operational strategies could be employed to best and most effectively minimize land contamination?” And that rephrasing of the question is really the key to the body of work I'm going to talk about. The outcome really adds, in my mind, to the toolbox of available options for operators. It doesn't seek, never has the intent of saying whether the filters are good or bad. It helps with the understanding of as severe accidents progress, what could you do, what should you do, to minimize land contamination effects.

The analysis we did is by necessity generic. It picked a plant. And as Maria's talked about, a pilot has recently been conducted taking the generic data and applying it to a specific plant and seeing what specific actions may be taken. So just bear in mind as we go through these with necessary generic analysis. Moving on to slide two please.

The results were published in the report, referenced here in September. There was some dialogue with the NRC staff along the way to try and understand different assumptions in the EPRI analysis compared to the NRC analysis, and there were different approaches, naturally. Fairly close alignment between inputs, and the conclusions at the end, there were some significant similarities in conclusions in the impact, the effect of water on scrubbing contaminants, et cetera. Many scenarios were run, many sensitivities, covered Mark I and Mark II containments. So significant number of code runs, analyses, and studies. And I should point out this point: the analyses were based on existing, well-understood, physical phenomena, like the scrubbing effect of water, the scrubbing effect of sprays in containment. Those are well-known, well-documented, well-tested phenomena.

And then also we used computer models which are well-respected throughout the industry. The models were integrated so there are questions around as temperature of water rises, the scrubbing efficiency reduces. That is actually imbedded in the model, recognizes as the analysis progresses, that efficiency decreases. So it's a very integrated analysis. As I said, the results were broadly similar with the work done by the NRC staff. And as Maria mentioned, ACRS review was very complimentary of the work that was done. And as you're aware, we have membership in EPRI beyond the U.S. utilities and there's been significant interest from our global membership as well and significant input from our global membership on the progression of this, and just the understanding that's being gained on the progression of severe accidents and what options could be. So moving forward to the next slide.

This slide tries to show the scope of this analysis. Clearly if the

core damage is prevented, containment's not challenged or whatever. So the blue box on the left-hand side, the analysis doesn't address that. The focus of analysis was on if containment is the primary barrier to release following core damage. And it shows the analysis focused on not just on filters, and are filters effective, but looked at the efficiency of combined strategies of spraying and flooding and filtered vents. And that is how we approach this analysis. Where containment's not the primary barrier to release, and where there's a containment bypass through whatever scenario may get you there, the analysis wasn't focused on a containment bypass event but I will point out at this point, there is benefit in the strategies developed in a containment bypass event. If you are scrubbing radionuclides by water in containment, clearly the path by which the gas exits containment is immaterial because you've already scrubbed at least a proportion of the nuclides in the water in containment. So moving on to the next slide.

So the basic premise of the analysis, there's no deep learnings in here. Avoid core damage, if the core's damaged, cool the core. If the core exits the vessel, protect containment. Keep the core in containment. This is the premise, the mindset going into the analysis. Cool the corium, again to protect containment. If you don't cool the corium containment integrity will be challenged in some analysis very quickly in the analysis, the containment can be breached by not cooling the corium. So that becomes core to the analysis.

Next is clearly vent when needed. If you're cooling the debris, the next challenge to containment is over-pressurization of containment, so you do need to vent. In that venting, you also need to consider the impact of hydrogen. And clearly if you're venting, looking at the potential release of radionuclides. So

again, there are no great learnings there, it just shows the thought process we went through. Next slide please.

So as we developed our strategies and the analysis, we had to come up with a mechanism to compare the effectiveness of strategies. So we chose to look at a concept we'll call decontamination factor. We ran using NRC MAX code looking at the magnitude of land contamination against the amount of radionuclides released from various accident scenarios. And we developed this curve which is in the report which shows a decontamination factor of 1,000 is a -- it looks like a very good benchmark for strategies to look at effective filtering strategies. And you see the knee in the curve decontamination factor of 1,000 and the relative magnitude of land contamination at that decontamination factor. And when we looked around the world at different filter designs and what various other agencies have required, 1,000 is comparable with filter designs in other agencies. So that was the benchmark we set in our analysis to say, okay, can we get through strategies including filters, not including filters, whatever, to get to a decontamination factor of 1,000. That isn't necessarily a mark of success, that is just a benchmark we set in our analysis.

So moving on to the next slide which is a graphic of the results from Mark I containment and the slide after this is Mark II, so I'll focus most of my comments on the Mark I. Looking at the bars on the left-hand side, first bar, no venting. If you don't vent, then there's no -- those three bars on the left-hand side with no cooling of the debris. If you don't vent and there's no cooling of the debris, containment will be breached, is what the analysis says and there will be a release to the environment. If you don't cool the debris, and you spray and you flood or you have a reliable hardened vent, containment will still be breached by

the corium melting through containment. The third bar, the yellow box shows the impact, the added impact of a filter. If you have a reliable hardened vent and you filter, there is some benefit because there's some period before containment's breached but there will be still be a significant release to the environment.

The final two bars on the right-hand side show the impact of cooling the debris and spraying and flooding and reliable hardened vents. And it shows that with a reliable hardened vent, decontamination factor approaching 500 can be achieved. But with a controlled reliable hardened vent the decontamination factor over 1,000 can be achieved. And the differentiation with the controlled vent is the containment is not left open so it can effectively breathe and maybe draw oxygen in leading to potential for hydrogen ignition. And also it allows periods of time with the vent closed for the spray to be more effective and remove radionuclides from the containment environment. So the scenario shows if utilities can come to a position of spraying and flooding, and have a controlled reliable hardened vent, our analysis shows the decontamination factors over 1,000 can be achieved without a filter. It doesn't mean filters might not be needed in certain circumstances but shows in the generic analysis decontamination factors over 1,000 can be achieved.

In the interest of time, I'll move on to slide nine which shows significant conclusions. Again, nothing tremendously surprising: maintain containment integrity, water injection to the containment cooling the debris, and filters potential releases. The water spray and flood filter those airborne aerosols, the spray is very important in removing those airborne aerosols. Cycling of the vent maximizes the aerosol removal and manages the hydrogen issue. And the analysis shows that decontamination factor of 1,000 can be

achieved. Now my final point is really to go back to reemphasize this was a generic analysis, specific plant evaluations of the impact of how to employ this would be required. But we believe it's a very sound analysis reviewed by a number of external bodies, and it's something I'm very proud of the work my team has done. Thank you for the opportunity to comment.

CHAIRMAN MACFARLANE: Thank you. Okay. And now we will hear from David Lochbaum who is the director of the Nuclear Safety Project at the Union of Concerned Scientists. Mr. Lochbaum?

DAVE LOCHBAUM: Thank you and good morning. I often appear before the Commission or its staff to criticize the path being taken by the agency or the pace along that path. I welcome this opportunity to applaud the path and the pace today on the filtered containment vent issue. It truly is a timely path to success. Slide two please.

The NRC’s near-term task force took the first step by recommending that reliable hardened vents be required. Slide three please. NRC senior managers took the second step by supplementing the task force's recommendations with the issue of filters for the vents. Slide four please. The Commission took the third step by directing its staff to merge the filtered containment vent issue with the tier one reliable hardened vent recommendation. Slide five please. The Commission took the fourth step by authorizing its staff to order reliable hardened vents be installed while the filter issue was being considered in parallel. Slide six please. The NRC staff took the fifth step by recommending that filters be required for the vents. Next slide please.

The next step is for you to authorize the staff to require engineered filtered containment vents. It's the final step on this path to success. If

implemented, UCS believes the programmatic requirement section of the final order should explicitly address limiting conditions for operations and associated allowable outage times for the filtered containment vent system. Slide eight please.

So we believe the success path includes a reliable filter in all, not just some, release pathways. Slide nine please. For its assessment staff assumed an average core damage frequency of two times 10 to the minus fifth per reactor year and a value on order of magnitude higher than that to cover uncertainties. Next slide please.

These values represent the mid-point and bounding value for U.S. BWR core damage risk from internal events. The chart has the values misidentified; both should be an order magnitude up on the vertical scale, it was my mistake. It's curious that the internal risk -- event risk values would be applied to a study prompted by an external event. Slide 11 please.

The staff noted that there are 31 BWR Mark I and Mark II units in the U.S. that have an average of 25 years remaining on their operating licenses. In recent years the U.S. fleet has been performing at about 90 percent capacity factor. Next slide please. These numbers yield a 98.6 percent chance that this subset of the fleet can operate over that quarter century without experiencing a core damage event. Accounting for uncertainties drops the odds to 86.1 percent. The chance of an accident is low but not so low as to dismiss. Next slide please.

While the risk of core damage does not equate to the risk of a severe accident involving extensive core damage. The fact remains that when an accident releases large amounts of radioactivity in containment, it's clear that filtered releases have significantly lower consequences than unfiltered releases.

Slide 14 please. The text within the red rectangles indicates that filtered or unfiltered releases make little difference in the number of prompt fatalities. But the text highlighted in yellow indicates that filtered releases make a huge difference for other consequences. Slide 15 please.

Filtered containment vents have undeniable value in mitigating the consequences of reactor accidents. Next slide please. With the exception of India, Mexico, and Spain, all BWRs operating in the rest of the world have already installed filtered containment vents or have committed to do so. Slide 17 please. According to the European Commission, only 32 of approximately 145 reactors operating in EU member states lack filtered containment vent systems. And this covers all reactor types, not just BWRs. Slide 18 please. BWR Mark I and Mark II designs are particularly vulnerable on this issue due to their small size and high post-accident pressure. Slide 19 please. Most of the Japanese fleet of reactors survived the one-two punch of earthquake and tsunami, but few survived the knock-out blow to the public's trust in the industry and its regulator to protect them. Slide 20 please. So if filters are not installed on all release pathways, the U.S. would essentially be gambling its entire fleet or 20 percent of our electricity that an accident with a large release of radioactivity doesn't happen. It would be impossible to justify not implementing the solution the rest of the world has applied. Slide 21 please.

Option 4 relies on the scrubbing effect that water in suppression pool in wetwell can have on radioactivity moving through it. The wetwell thus serves as the containment filter in Option 4. Slide 22 please. We prefer Option 3 to Option 4. Neither provides 100 percent assurance that all radioactive releases will be attenuated by the filter. But Option 4's less likely to perform this invaluable

filtering. Slide 23 please. Among the reasons is that Option 4 becomes less effective when an accident progresses to damage fuel becoming ex-vessel. Slide 24 please.

As EPRI's recent study pointed out, some Mark II designs exacerbate this situation by providing a potentially large pathway for radiation to bypass the wetwell and flow directly into the drywell through the sump line. Slide 25 please. Option 4 also becomes less effective when flow enters the suppression pool other than through the safety relief valves from the reactor vessel. Slide 26 please. Option 4 also becomes less effective if the flow arriving in the wetwell arrives by the safety -- by safety relief valves is not diffused into tiny bubbles by the T-quenchers. Slide 27 please. It's a busy slide but the red line shows the path through the safety relief valves and T-quenchers into the suppression pool. Large or small, the bubbles are discharged near the bottom of the pool for maximum scrubbing before breaking the water's surface. The magenta line shows this pathway through the vent pipes and downcomers. Large bubbles are discharged near the middle of the pool's height for shorter, less effective scrubbing distance to the water's surface. Slide 28 please.

Option 4 also becomes less effective as the temperature of the suppression pool's water rises whether by RCIC and HPCI operation or scrubbing the flow entering via the safety relief valves and vent pipes, the water heats up and decreases the effectiveness of the scrubbing effect. Slide 29 please. By its very nature, beyond design-basis accident follows no pre-conceived script. Many failures conspire to take the plant beyond its design basis. The staff's probabilistic risk evaluation for the filtered containment vent system reinforces this point: the passive nature of a ruptured disc in the vent path

makes it more reliable than a path with isolation valves. Valves can fail to open or fail to be opened by workers. This same reliability issue is a much larger concern for Option 4 given all the active measures involved in getting it to work right. Slide 30 please.

Option 4 has a risk of unfiltered releases through the drywell vent path. That risk has very high population dose consequences. Slide 31 please. Option 3 better manages the risk of unfiltered releases via the drywell pathway and thus more likely avoids the huge financial cost of failure to do so. Slide 32 please. Consider for a moment if Fukushima Unit 2 had already had Option 3, and Fukushima unit four already had Option 4 installed before March 11, 2011. Which unit would likely have caused lower population exposures, financial costs, and contaminated land acreage? Clue, the answer does not rhyme with three. Next slide please. To sum up, the Commission and its staff have taken several steps at an appropriate pace along a path to success. The next step towards success is yours to take in approving the staff's recommendation to require the installation of an engineered filtered containment venting system. Thank you.

CHAIRMAN MACFARLANE: Thank you. Just have to note that it's very impressive to get through 33 slides in 10 minutes.

DAVID LOCHBAUM: I cut it down from 100.

[laughter]

CHAIRMAN MACFARLANE: Okay. On to our next and final panelist for this morning, Mr. Ramzi Jammal. Welcome. He is the executive vice president and chief regulatory operating officer at the Canadian Nuclear Safety Commission, our counterpart in Canada. Welcome to the United States. We look forward to your comments.

RAMZI JAMMAL: Thank you very much. My apologies for walking in late, the weather up north is different than it is here.

CHAIRMAN MACFARLANE: You're actually having winter.

RAMZI JAMMAL: Lots of it.

CHAIRMAN MACFARLANE: [laughs]

RAMZI JAMMAL: Thank you Madam Chair, members of the Commission or Commissioners, we're glad to be here today to give you an overview of the regulatory oversight in Canada. And I will start with the Commission members who are independent and render their decision independent of each other, so each one renders their decision and the role of the president is to break the tie. The Commission issued the licenses once it's satisfied that the operations -- sorry, I'm on slide number two. The Commission issues the licenses once it is satisfied that the operation is safe and the term of the license is five years. And the applicant and the operator must produce an application in order to have approval for the renewal. The adequacy of the licensee program is evaluated past performance and the continuous enhancement as a requirement by the performance-based regulatory requirements and we have in Canada both, the performance-based regulatory principle and prescriptive.

So hence, once the application comes in for what we call long-term operations or life extension, known as refurbishment, there is a self-assessment conducted by the licensee which is what you call integrated safety review program that looks at all the whole safety systems and determine on several criteria, one of them is cost benefit, the other one is the redundancy and enhancement of the facility to meet or exceed international standards, or start to

meet the requirements of a new power plant. So the intent out of the ISR is an integrated improvement plan that the Commission approves and becomes part of the operating license of the applicant. Slide number three please.

So the CNSC adopts international standards with respect to our assessments, after staff has assessed, we provide recommendation to the Commission. It's risk informed and based on defense in depth strategy. So the safety goals are formulated in addition to their domestic design requirements, so that the risks to the public that originate from accidents is taken into consideration. So these safety goals are consistent with the currently accepted international practices. For existing operating reactors they are used as a requirement to justify the long-term operations. Now for beyond-design-basis accidents the plant design must be capable to meet established safety goals and to include such as performance-based and practical measures to halt accident progression in order to return the plant to controlled state and mitigate accident consequences.

Now from the performance perspective the containment shall maintain a leak tight barrier for a period of approximately 24 hours following the onset of a significant core damage. In addition, the containment shall continue to provide a further barrier against uncontrolled releases of radioactivity by withstanding potential challenges associated with the severe accidents. So the containment shall have the design capability to remove heat and reduce pressure inside the containment structure to minimize pressure induced release of fission products to the environment, to control hydrogen concentration, as we heard to prevent deflagration which would jeopardize integrity of the containment structure, and to control removal of fission products, hydrogen, and other

combustibles. So the filtered venting is an example of enhancement that design improvement that the Commission approved and the licensee had to put in place as part of condition for them to restart and refurbish the reactor. Slide four.

The general principle of the regulatory requirements in Canada is based on the dual failure system where it takes into consideration such as the heat transport system pipe break combined with the coincident failure of the cooling injection. So this was used as the limiting accident for the containment design. This approach led to the consideration of the selected beyond-design-basis accidents and the design basis of the NPPs in Canada, or nuclear power plants. This also led to specification of design criteria for the safety and safety support system such as the separation, independence, redundancy, and diversity requirements. So overall, the adoption of the system has restarted in a significant number of robustness in the original design. We've added the probabilistic approach and was introduced to assess whether the support system defenses were sufficiently independent and whether the reliability of the safety functions could be maintained with a sufficient high degree of confidence. So this approach was used to confirm robustness of design-basis Level 1 PRA and are needed to define reasonable and practical safety improvement Level 2 PRA, essential to assess beyond-design-basis accident prevention mitigation.

So these strategies are in consideration to hold accident progression, return the plant again to its controlled state and mitigate accident consequences and more specifically to identify the redundant capability to again remove residual heat from the core debris and transfer it to ultimate heat sink and control removal of fission products, hydrogen, and other combustible gases. So these safety goals are not described in our regulations but they are required

in order to have long-term operations approval. So number five please.

So post-Fukushima review of Canadian nuclear power plants confirmed that the safety case is still valid and robust, and to include the effectiveness of the containment as a leak-tight barrier following the onset of severe core damage. The Commission itself has challenged staff and required us to reevaluate the consequences of an event, taking into consideration failure of the mitigation measures. So in other words, keep evaluating, take into consideration that mitigation has not been successful. So we ended up with -- to mitigate consequences of design basis accident, the CANDU six single units which are designed to be a positive pressure following a large LOCA combined with a coincident failure of a cooling injection. They are equipped with pressure suppression capabilities through dousing systems and local air coolers. In Canada we have the multi-design units that have a common containment envelope through the provision of the large-volume vacuum building -- I'm sorry, large vacuum building, which will maintain the containment system sub-atmospheric following accident.

The containment for each unit is identical to single unit, however, the multi-unit design in addition has seismic-qualified and powered emergency filtered air discharge system for removing heat from the containment. So to mitigate the consequences of the beyond-design-basis accident, the CANDU six single units require the installation of emergency containment filtered venting system to prevent containment failure. Design options for multi-unit is under consideration and is being finalized, taking consideration the existing design features that are already installed. So a large part of the reason for containment venting has been mentioned, is to remove heat and pressure, and pressure build

up from the containment and introduce diverse complementary design options needed with the objective to have the capability of remove heat without venting, and to protect containment through additional measures in place and capability, such as venting for redundancy purposes. Slide number six.

I'd like to share with you, technically, the specifications of the system that was installed at the power reactor. And in specific the slide number seven, the system is installed on site and it needs to exceed seismic margin assessment of .4 G which will present high confidence, low probability of failure for prevention of large releases. The system does not require external power source, it operates passively through relief containment pressure and the vast majority of fission products. So the system operates by passing the vapors vented from the containment through scrubber filter vessel to remove high activity radionuclides and aerosols. So in detail, the vessel contains liquid scrubber system with 21 venture-eye nozzles submerged in alkaline solution. The system is normally isolated from containment and is activated manually only when required. The filtered exhaust is vented to reactor stack. As outlined in slide number seven, the system is highly effective, it has a very high radionuclide removal rate. However, it does not remove noble gases or tritium.

So, on slide number eight is a representation of the installation of the fixture itself of effluent scrub, significantly reduce the release of radioactive materials to the environment. And slide number nine is pictures, illustrate the system is housed in seismic qualified enclosures outside the containment itself. And slide number 10 is showing the pictures of the installation of the stack and the filter exhaust, or effluent is vented through the stack adjacent. And thanks for having us here. And we’re ready to answer any questions.

CHAIRMAN MACFARLANE: Great, thank you very much. Okay, thank you all very much this morning. This was a very useful session. We will now turn to questions from the Commissioners, and we will start off with Commissioner Ostendorff.

COMMISSIONER OSTENDORFF: Thank you, Chairman. Thank you all for being here today. This is a really important topic. And I especially welcome our Canadian colleague, and I appreciate you traveling for this meeting.

I'm going to start out with -- the staff recommendation to us is obviously for Option 3 in the paper, and so there's a lot of discussion on three and four. I'm going to probably stay with those two options to look at that but recognize that there are four options presented. And I wanted, perhaps, to start out with Maria in that light. One of the interesting things for me, having -- as other commissioners do, being -- focusing heavily on this issue through its evolution and through our steering committee and the JLD deliberations on this. It's interesting to me to see how a number of the senior staff perhaps originally were all supportive of a performance-based approach, a.k.a. Option 4. But as time went on, there appears to have been a convergence to the staff unanimous recommendation for Option 3. And one of the key considerations given in that rationale, in my discussions but also other Commissioners' discussions and in their staff paper was "We don't want an Option 4 approach to turn into another GSI-191."

And there's been a lot of discussion on that particular topic, as pragmatically how does one get to performance objectives in the time period that would bring this to closure in an appropriate time, however one defines appropriate time. I know Maria, in your -- I think I wrote down exactly your words.

I believe you said that Option 4 could be pursued consistent with the schedule for Option 3. Neil, in your Slide 10 you talked about the need for specific plant evaluations. This topic came up in an ACRS meeting before the holiday period. And I'm just curious if -- especially if the first three people here could respond to your thoughts on the staff reaction that, "Well, there are some merits theoretically and philosophically for a performance-based approach, but pragmatically a lot of pitfalls to an Option 4." So I'd be interested in your thoughts on that.

MARIA KORSNICK: I'll start, and then Preston or Neil, I'll ask you guys to jump in. You know, I guess to just kind of reflect on when we say GSI-191, to give it the unfortunate label that it's a challenge for us, essentially it's wrapped around, you know, testing and the results of testing and views of what the results of the testing mean, et cetera. I believe that we can head down this path and not get ourself into a testing challenge, because I don't think testing needs to be done. I mean, I think the research has been done. And I think the performance-based criteria can be things like deliver a certain volume of water in a certain period of time. And I think we can prove the capability and the function of doing this without getting wrapped around testing requirements. I think we need functional performance requirements that I think can be -- can be very straightforward. Obviously, you know, this would have to be, you know, worked out in terms of what the guidance would actually be. But, I mean, I have a view that doesn't take us down that path. I would --

COMMISSIONER OSTENDORFF: If I could interject, just so -- and then Neil will comment, but while you have the microphone, the note that Neil has about specific plant evaluations being required, do you see that that is not actual testing of some kind of a prototype?

MARIA KORSNICK: I don't think that it has to. I would share the tabletop exercise that we just did in December at one of my plants, where we took the methods that Neil's generic analysis used and we applied it to my plant; so you run the models but you use the equipment that you could operate. Well, then my equipment can inject at 300 gallons a minute. Well, then don't use Neil's generic number, use 300 gallons a minute because that's what I'm going be able to put in. So it tailors those models to the equipment that I have to actually put my hands on and use. And so again, I don't think that we need to get ourself in a testing scenario.

Conversely I would challenge that if's there a concern over GSI-191 problems, I'm not sure how an engineered filter escapes the GSI-191 problems because whatever we have to put in, I'm sure there's going to be requirements, and then you're going to tell me, "Well, Maria, how do you meet those requirements?" And so, I guess my challenge becomes, I appreciate the concern over GSI-191. I don't see it -- I don't see it limited to Option 4. I see it actually applies to Option 3 and 4. And my challenge is we are smarter than that and we don't have to fall into pitfall. And I think there's openness on my part as well as, I believe, the staff to come up with criteria that wouldn't take us there.

COMMISSIONER OSTENDORFF: Okay. Preston, do you have anything to add to that?

PRESTON SWAFFORD: Just from an applied standpoint, the doability part of it, I think is also -- we've got so many activities moving already in the arena of Fukushima, and coping strategies, et cetera to make a final decision after the performance analysis is finally concluded such that you're not wasting company time, money, and resources, that sort of thing I think is very doable

within the timeframe. Like I had mentioned, we're already building a filter building as a template because I don't want to redo mods. So that standpoint is important.

And I think that at TVA we've also learned -- because like I mentioned, we've started on the filter path almost from day one as a potential option. But as we get more intelligent about once containment fails, the usefulness of "You don't have the mode of force to move it down the filtered vent line, et cetera, et cetera" starts to occur, that the actual practical use of that becomes diminished. So there is a window where it might be in play, and that's what we're studying and evaluating right now. But I think it fits under the performance-based approach to do that as opposed to essentially to meet, I think, Option 3 as we're going to go install a wet filter as the only vehicle. And if it turns out that that's not a bottom line value add somewhere down the road, we've just done a significant expenditure for really not a net gain, and I've learned enough from the calculations and analysis from EPRI and others to know that it's a little bit becoming clear the subject that we're starting to know a lot more about, as opposed to a year or two ago when we were kind of into the what can we do to make a difference.

COMMISSIONER OSTENDORFF: Neil?

NEIL WILMSHURST: Okay, very quickly, I think Maria made a good answer. Unfortunately, no two plants are identical. So, the real intent of the comment you've picked up on from my slide about plant evaluations is pretty much characterized by the pilot, which was recently completed at one of Maria's plants. Every plant under this scenario would need to consider whether the strategies identified within the EPRI report could be credibly employed at that

site, understand whether any modifications were needed, and whether those modifications could be effectively conducted. And of course that evaluation should and would, I'm sure, include the potential for applying a filter. So I think every plant would need to take the output as an element of a toolbox of options and decide what that meant to that plant.

COMMISSIONER OSTENDORFF: Okay, David, I'm going to provide you an opportunity here for any comments you want to make to that.

DAVE LOCHBAUM: In my presentation, I didn't speak to the timeliness issue because we're more concerned about getting it right than getting it done fast, and our problems with Option 4 aren't so much -- they're not timeliness at all. They're a reliability standpoint and our concerns about the reliability would have been better addressed if recommendation one to the near term task force recommendations had been implemented, so we'd know what kind of quality standards, testing standards, and other things went with the Option 4 features. Right now, that's a work in progress. We don't know how much credit to give to those things. So, we give it no credit, basically. Option 3 is something we know what that value is. We can measure it, and it's not IOUs, and there's less uncertainty. So, that was the bigger factor than timeliness.

COMMISSIONER OSTENDORFF: Okay, thank you. Ramzi, I'm going to ask you a question here. In your presentation, you talked about the Canadian approach and I wanted to just bore down to one aspect. Did you provide -- how prescriptive was the Canadian regulator decision with respect to a particular type of filter or I saw you had this slide that had the technical specifications. Was it you can go chose any filter that would fit and meet these performance requirements? Can you talk about a little briefly?

RAMZI JAMMAL: That's a very good question, thank you. The action items arising from the Fukushima task force or even pre-Fukushima was and still is performance based, so depending on the site specific itself, and the plant itself, and the design itself. So the requirements for filtered venting is an enhancement in order to maintain the integrity of the containment, and if there is -- in case if there is any controlled venting, then it will be providing adequate protection for the public and the environment. The regulation does not prescribe in detail exactly what is in the slide, however the performance base by achieving the best available technology and best available, based on our principle that is as reasonable as achievable, taking the cost benefit factor. That what was applied. So the applicant, the licensee, has -- did the evaluation and proposed actually this filtered venting and we reviewed from staff, and we accepted it from a regulatory perspective, and taking consideration again on the protection of the public and the environment. If I didn't answer your question, I can explain a bit more.

COMMISSIONER OSTENDORFF: That's fine, thank you. Thank you, Chairman.

CHAIRMAN MACFARLANE: Okay, thanks. All right, my turn next. So let me start off with you, Ramzi. Nice to see you here. So expanding maybe a little bit on Commissioner Ostendorff's question, did Point Lepreau or other nuclear power plants do a PRA to evaluate the performance of the filters?

RAMZI JAMMAL: That's correct. There is -- the PRA is used as a complement, to complement actually the design principles in order to determine the effectiveness. Yes, the answer is the PRA is being used in order to --

CHAIRMAN MACFARLANE: And what's the result of the PRA?

RAMZI JAMMAL: I have to rely on my director general, Dr. Rzentkowski, if I may in order to --

CHAIRMAN MACFARLANE: Sure. You can go up to the microphone over there.

GREG RZENTKOWSKI: Thank you.

CHAIRMAN MACFARLANE: Thanks.

GREG RZENTKOWSKI: Just to clarify this point, we prescribed a performance objective. So generally speaking, we identified what needs to be done. It's up to the industry to decide how to meet those performance objectives in a very holistic fashion. So, something like cooling retention, suppression in the containment, everything will be taken into account in this overall holistic approach. Now coming back to the question, what was the result of PRA. Yes, the need for the filtered vent in the containment was identified as a result of Level 2 PRA, and we established our limits and targets for this in order to meet the regulatory requirement, they had to install that filtered venting system. It's also one of deterministic requirements, which is very important, which is a redundancy of the safety system. Of course their containment is ultimately the last safety system and preserving its integrity of the overall containment envelope is primary responsibility of the licensee, and because of the redundancy of the safety system restart is very important.

CHAIRMAN MACFARLANE: Okay, thank you very much. All right, so let me turn to you folks from industry. Any of you have operator experience?

MARIA KORSNICK: Yes, I'm a previous SRO.

CHAIRMAN MACFARLANE: Okay, great. So, then you know, any of you welcome to jump in. Do you feel as in the industry that it would be -- as an

operator at a nuclear power plant that the decision to vent would be easier to make if you knew you had a filter?

MARIA KORSNICK: All right, I can speak to myself personally from the operator training that we receive, and I feel very confident that our operators would vent as necessary in containment, but I don't think a filter changes that, quite frankly. I would think if anything, the learning from Fukushima is absolutely how important it is to ensure that you're managing containment, because by managing containment you're actually managing a much bigger picture.

CHAIRMAN MACFARLANE: Anybody else want to comment?

PRESTON SWAFFORD: Well, I'll just speak to that. I think the obvious piece of that is that it certainly gives you a little bit of confidence, right? But in the end, does that move the needle or not is really what we're here about.

CHAIRMAN MACFARLANE: But it does give you confidence.

PRESTON SWAFFORD: Well, it, you know, I don't -- I think I'd be a little silly not to say it doesn't have some confidence for an operator behind the panel, but only if it's applicable, right, because there's a window --

CHAIRMAN MACFARLANE: Sure.

PRESTON SWAFFORD: -- what we are finding is its relatively small, where there's value add may or may not be cost justifiable, and then just being from the cost analytics that we deployed in the studies here, but on the other hand our training, that I do know. I mean the robustness of the training, how we participate and play, I have high confidence our operators are going to do the right thing, and protecting containment is engrained in them. And we've not built in the cultural issues of who gets to say if you will, can you vent containment or not, like obviously occurred over in Japan. So that difference

here, I think we're well trained, I think, and protecting the containments is the utmost responsibility of the operators, and I have really high confidence, even if they live close by the plant, they're going to do the right thing and preserve the integrity of the containment.

CHAIRMAN MACFARLANE: Mr. Wilmshurst, while Mr. Lochbaum was talking I saw you nodding your head a bit in his analysis of the Option 4, and that the wetwell scrubbing effect works only in some scenarios. Do you agree?

NEIL WILMSHURST: Yes, when we went through the BWR Mark II containment, Mr. Lochbaum correctly points out there is a design feature of most Mark II containments where there's potential bypass from the wetwell through the sump drains. That was one of the inputs to our analysis, and when I was answering Commissioner Ostendorff, I mentioned about the plant-specific evaluation. Mark II plants would have to analyze are there credible modifications to eliminate that bypass path? So yes, it's a fact that would have to be addressed by Mark II plants. I believe there are potential design fixes that could be employed to do that.

CHAIRMAN MACFARLANE: Okay, and what would those design fixes be that would be a mature technology, like a filter comparable?

NEIL WILMSHURST: No, it's actually modifications to the actual sump drains themselves. I believe Maria may be better placed to talk to that issue. I know she's looked at that.

MARIA KORSNICK: Yeah, and I believe there's a plant that has already implemented this, but it's a process whereby, if you will, ceramic beads are put in place, and as a result of the corium actually hitting the sump drain, it

actually creates a blockage. And so that you don't actually have the bypass scenario.

CHAIRMAN MACFARLANE: And the ceramic beads are made of --

MARIA KORSNICK: Ceramic.

[laughter]

CHAIRMAN MACFARLANE: Yeah, those are minerals, and I'm just trying to -- interested in what minerals those are. Anyway, that's a highly technical question for another time. Okay so Maria, can you tell me something about your estimates of the cost involved in your approach?

MARIA KORSNICK: Obviously it varies by plant. You know, for installing a hardened vent for both the wetwell and drywell, we had estimates of approximately $12 million. We talked about in addition, requiring additional equipment potentially for the FLEX strategy, and so again, it kind of depends if you're a Mark II and you have to make this drain line modification. That would be in addition, I don't have those numbers off the top of my head. I guess I would just share with you that it's not an insignificant investment that we would be making.

CHAIRMAN MACFARLANE: Right, but there would also be additional costs from PRAs if a plant chose to do that, then from you know, there would probably be additional costs from all the analysis involved over time going back and forth with the NRC staff, et cetera, correct?

MARIA KORSNICK: There's definitely cost involved with analysis work.

CHAIRMAN MACFARLANE: Okay, do you have any comment on the cost?

PRESTON SWAFFORD: Well, the total Fukushima bill, which our coping strategy, which is a big part of this filtering comment, that I think I've plowed enough this morning. That whole bill is roughly around $185 million --

CHAIRMAN MACFARLANE: [affirmative]

PRESTON SWAFFORD: -- for my entire fleet. So, that's all six units, but the high end on a wet filter we've looked at is around $20 million a unit on that. So, we've been working -- if we end up having to go there, can we make a dry filter system somewhere around $2 million a unit as a potential viable option in the equation, but again, until the analysis is done, I can't tell you if even $2 million is a particularly good buy from a design standpoint. But right now, those are kind of the estimates and there has been some work frankly in the wet systems to try and drive cost down there.

CHAIRMAN MACFARLANE: [affirmative]

PRESTON SWAFFORD: So, there's a lot of different initiatives going on in the industry to see if we can, but --

CHAIRMAN MACFARLANE: Very interesting. So, you're actually talking about comparable costs here, Option 4 or Option 3? Okay, good. So --

PRESTON SWAFFORD: If we went ahead with the filter on four.

CHAIRMAN MACFARLANE: Right, right, exactly, exactly, the wet filter, we're talking about the wet filter and what Maria just said, the numbers that she just -- sounds comparable.

MARIA KORSNICK: I just would caution, obviously it's a plant-specific analysis. I would just caution somebody to make a generic --

CHAIRMAN MACFARLANE: Sure.

MARIA KORSNICK: -- statement.

CHAIRMAN MACFARLANE: I completely understand that some plants would have to do more for a wet filter, if there was a lot of seismic stability work, blah, blah, blah. Okay. Just trying to understand that better. Okay, I have a little bit of time left. Mr. Wilmshurst, in your assessment of the decontamination factor, does the model that you use to do that analysis have any physical test data?

NEIL WILMSHURST: The analysis was done using existing computer codes. There's no physical testing done, but the -- it used codes which are validated and used throughout the industry based on previous experimental work, but no testing done to support this particular effort.

CHAIRMAN MACFARLANE: And Mr. Lochbaum, do you have any comments on the decontamination factor model?

DAVE LOCHBAUM: Well, as I read the EPRI report, if I understand it correctly, it was not just relying on the scrubbing through the suppression pool water, it was also dry well sprays and other sprays to help remove aerosols and particulates from the air. Our concern that we addressed in the staff meeting months ago was that if you had water and the ability to inject it, you'd probably be putting it into the core to prevent damage. So, you've lost a lot of capability. So where does this magic spray power come from? It's possible that it would arrive later, be fixed, or whatever, but it seems more likely that you're in this bad situation because you've lost all that capability. So, you can't get this magic water spray. So, whether or not the math may work out, does the reality support

that? And that's our concern is that it's not a realistic scenario, although the math works out.

CHAIRMAN MACFARLANE: Okay, great, thank you, on to Commissioner Svinicki.

COMMISSIONER SVINICKI: I'll add my thanks to each of you for your presentations. I sometimes reflect on the complexity of the topics that we ask presenters to address, and then we give them -- sometimes we give people five minutes, and I will say to Mr. Lochbaum that the Chairman as kind as she was actually diminished your accomplishment you had I think a minute and eleven seconds left when after getting through your 33 --

[laughter]

-- slides. So, that adds to the magnitude of what you achieved. When I was looking at them this morning, I thought, I wonder if Dave's just going to skip a bunch of these, because how else could he flip them as fast as we were going through them. But anyways, you know, thank you again, to all of you. You've covered a lot of information in a very short period of time. Thank you for -- the reason that we just like to have a lot of different presentations and presenters so we shave the time so thank you for helping us having to juggle that, but I think it's very valuable to have all of you here today. Mr. Wilmshurst, in your presentation today and consistent with my prior knowledge of the EPRI work, there is an acknowledgement that the possible outcome of an Option 4 performance based approach would be filters at the sump sites, installation of filters. So, I saw that again acknowledged on your slide 10. Is there any way of knowing based on our state of knowledge today the percentage of units or how many are likely? And I think that it seems to me in some instances may come

down to a station under Option 4 may elect filters simply because it is a recognized path for compliance. So they may at some point, as Maria was talking about, all the engineering labor is a very expensive thing, at some point you might just say, “Well, we’re going to elect to install the filter because of its simplification of our compliance with this.” Do we have any sense of, you know, would it be half of them or only 10 percent?

NEIL WILMSHURST: We haven't done that analysis per se, because as I say, unfortunately no two plants are constructed the same. My perspective would be it really probably comes down to a cost benefit decision, risk-informed decision based on how difficult would the modifications be, how expensive would they be, how credible would they be, and whether a filter was a more appropriate step to take for that particular plant.

COMMISSIONER SVINICKI: Okay, and I'll ask Maria and Preston as well, again, you interact with your industry colleagues. Do you have any sense or would you care to venture, you know, how many licensees if the Commission approved Option 4, would likely end up with filters? Do you have -- is there any way to have any sense of that, or maybe everything’s so speculative that you don’t want to venture at this point?

MARIA KORSNICK: Yeah, I feel uncomfortable venturing. I’m not sure if everybody’s sort of fully thought through their strategy. The only one I know who is as advanced in looking at filters is TVA.

COMMISSIONER SVINICKI: Okay, okay, thank you. Fair enough, and I was reading a transcript from an ACRS meeting. I won’t take my time to find it in this thick binder at my feet here, but after the ACRS meeting and the open mic period, a representative of NEI spoke and said that the cost benefit

analysis that the staff had done included only a solicitation from vendors of the cost of the filter, and it did not include all of the analysis and then the utility cost. Does anyone here have an awareness of whether or not the staff's -- I did not have time in preparation for the meeting to look at the detailed breakdown of what the staff considered as far as cost, and my understanding was they went no further than simply the vendor, what the vendor would charge.

MARIA KORSNICK: Yeah, I'll just reflect on that briefly without getting wrapped around detailed numbers, but one thing you do need to be concerned about and I think actually was shown in the figures that he characterized where you saw the filter vessel if you will, but then you saw the building that this filter vessel was being put in. So if you're going to talk to a vendor and you're going to say, "How much does a filter cost?" they're talking about the filter vessel part, right? Realizing now that you've created a source term external from containment, of course we're interested to make sure that that's protected. So, now you have to put in a building that's robust enough or have a building that currently exists. As Preston already mentioned, he's building one or creating that footprint, and so the vendor doesn't look at that necessarily as a cost for them, but from the utility, you want something that's, you know, obviously able to be used. And so, you know, there's at least several million dollars in addition to typically what the vendor is talking about, even from an installation perspective, and that's you know, in addition to, you know, generally engineering cost.

COMMISSIONER SVINICKI: Okay, and I'll pursue this with the staff. Certainly they're going to be familiar with how they conducted their analysis. I wanted to return to the issue of the complexity of kind of operator

actions and things like that. Certainly the ACRS had some engagement with the NRC staff on this point. Chairman Macfarlane has raised that this morning. I know that we do have -- Maria, you were a licensed SRO, but we have -- the Commission had a meeting in November I think it was, on operator licensing and training issues, and I was curious about this point at that meeting, since we had the representative of the Professional Reactor Operator Society. I had enquired of him at that meeting, the transcript is publically available, but just to paraphrase I kind of said, “Should I be confident as an NRC Commissioner that if we were in an accident scenario at a plant in the United States and your procedures told you to effectuate a series of actions like venting, should I be confident that a U.S. operator would carry out those actions?" and Brian Snyder, the vice president I think of PROS, he indicated this was his answer, again abbreviated. He said, “Yes, ma’am, you should, and the reason why is because when I received my license letter from the NRC, it specifically told me to operate the plant with all approved procedures and policies, and follow the management above me to take safe actions to protect the health and safety of the public, and me personally, I’m in the 10 mile EPZ. My family is right down the road. I live four miles from my plant. So, if I’m on that unit, you are guaranteed that I would take those actions, and if the managers and supervisors won’t let me do that, I will advocate it as much as I can before I take them, but I will take them to protect the health and safety of the public, and so would everybody with a license.”

So again, I was looking at the gentleman as he said this, and I don’t give it justice in rereading it, because he said it with great conviction. And so my question would be about -- because at the end of the day, in any severe accident scenario, there’s no regulatory measures that we can take that will absolve us of

being reliant on human beings, and certainly we have the very courageous plant personnel in Fukushima. I think they were profiled in the U.S. media again yesterday, but very heroic individuals, and so I think there is no option in front of us in this paper that will remove our reliance on operators doing what they need to do in those very, very difficult and trying circumstances. So, I don't know. We've got some different folks at the table, and David, I don't know if you'll like this to be mentioned, but you certainly have extensive background with the industry as well, and so I wondered if you would have any perspectives on what the operator said. Yes?

DAVE LOCHBAUM: I agree with your characterization of the commitment and dedication of the operators. That's been my experience at the various plants I've worked at. So, I don't doubt that if that was this time to come, that step would be taken. I have no doubt in that. I think the doubt that rises in the training and preparation of the entire crew to deal with that situation at a time. Severe accident management guidelines have been voluntary in the past. You have to have them, but you don't have to train people on them. You don't even have to have them in the control room. There's some uncertainty about the preparation to take that step, should that moment come. If we had better confidence that that training and all the attendant things that lead up to that step are there and reliable, then we'd match the commitment and dedication of the staff with not setting out for traps. So if we can remove that or lessen that, then we'd feel better about the whole situation.

MARIA KORSNICK: I guess I could respond to that. We obviously take severe accident management very seriously. We do train on it. I'd actually like to take this moment, I have one of my operators here in the room with us

today, and he participated in the tabletop exercise that we did back in December. And I guess I'd like you to hear from him directly in terms of his personal passion as an operator. You know, we don't have these engineered filters in place today, and what confidence you have that the necessary options we'll take --

COMMISSIONER SVINICKI: And if he could talk about the complexity of what an operator faces.

MARIA KORSNICK: Yeah.

COMMISSIONER SVINICKI: Yes.

MARIA KORSNICK: Phil Amway, if I can introduce you.

PHIL AMWAY: Yes, good morning. My name is Phil Amway. I was licensed at Nine Mile Point facility from June of 2005 through mid 2012 as a senior reactor operator, maintained that active license for that seven year period. To address the concern, first of all I'd like to start out by affirming the statements that were made in the ACRS presentation by the operator, and I fully support what was stated in there, and fully agree with it.

To expand upon that a little bit, as far as the severe accident management procedures, they are available in the control room and we do train on those, but I'd like to respond to this question in a two-part approach. The first being as can we implement the actions, are they feasible for me to do, and second of all would I actually do it should the time come where my procedures direct me to do it? The first part, as Maria already outlined, your orders that are already in existence to put in the reliable hardened vent actually make that task for an operator much easier to perform over the current design of the plant. She mentioned things in there such as it's going to have independent power supplies, it will be able to be controlled either remotely from the control room, or other

suitable location, or locally in the event that the control room actions are unsuccessful. It will have its dedicated power supplies and pneumatic air supply that will last for the first 24 hours into the event. She also stated there will be four to six times within that 24 hour time period. So, that answers the questions could I do it, would it be feasible for me to do it.

The second part of that question is would I actually do it when my procedures direct me to, and that I'll start out by saying overwhelmingly yes, as indicated by the operator that presented to ACRS and responded to questions there. But beyond what was stated in that dialogue that occurred was I agree that my license requires me to comply with the facility operating procedures, which would include venting as directed by either the EOPs or the SAMGs. But I want to also emphasize that that strategy for managing containment pressure already exists in the emergency operating procedures and the severe accident management guidelines, and the goal of that is to make sure that I can maintain the containment integrity by managing containment pressure.

So the license, even though it requires me to do that, I wouldn't follow those procedural actions blindly. I'm required to understand the consequences of my actions, and the impact it will have before I take those actions, and the technical basis behind those steps to vent the containment is that I have a choice to make. And that if I'm going to have a release, I have an option to have a controlled monitored vent path that I control, or if I fail to protect the containment integrity, that I would have multiple unmonitored release paths. So from a public health and safety standpoint, it's far better for me to be in control of that action at the time it is required.

COMMISSIONER SVINICKI: Okay, thank you very much, thank you Madam Chair.

CHAIRMAN MACFARLANE: Okay, Commissioner Apostolakis.

COMMISSIONER APOSTOLAKIS: Thank you, Madam Chair. David, in your -- you didn't elaborate today, but you have a slide eight, and in the past, you have been a little more detailed on it, your main argument being we have a filter for routine releases. We have a filter for design-basis accidents, but we don't have a filter for a case where the amount of radioactivity to be released is huge.

DAVID LOCHBAUM: That's correct.

COMMISSIONER APOSTOLAKIS: That argument is strictly consequence based. I mean don't you think you should take into account the fact that this huge release has a very low probability?

DAVID LOCHBAUM: Yes.

COMMISSIONER APOSTOLAKIS: So, you would still stand behind this argument?

DAVID LOCHBAUM: Yeah, because if that low probability comes in, then I want to have that large release filtered, rather than unfiltered.

COMMISSIONER APOSTOLAKIS: Even with -- okay. Well, thank you. And Neil, I don't remember your exact words, but you seem to be saying that the ACRS agreed with you, with your report and I'm going back to the letter, and I don't see an agreement. In fact, they do finish their letter by saying, "We think -- for example the following strategies are preferred, one, two, three, four, five, six." They don't say these are proposed by EPRI. On top of that, I've asked our staff whether there are specific strategies that have been proposed by

anyone, so that they will understand better this performance-based approach, and the answer I got was, “No.”

Now, the slides by Maria talk about, you know, cooling the core, the debris, blah, blah, blah, blah. Let me have a specific definitive answer. Is there at least one strategy that is out there so that one can go and say, “Here is something that could be used under Option 4,” or is it a generic analysis as you keep saying and then people who have to formulate the strategies’”?

NEIL WILMSHURST: There's a number of questions in there. First off, the work we did doesn’t come up with an answer. It doesn’t therefore get to a point did ACRS agree or not agree. If I gave that impression, it was incorrect. My point was ACRS clearly looked at the work and recognized that, if you like, it was valid and credible. Does that mean agree or not agree? That was never the intent. On the second one, and I’ve heard this conversation a number of times, is have strategies been proposed? Again, that wasn’t the intent of the work for my organization. The intent of the work and the EPRI report was to inform that discussion, to actually pass forward options which may be considered. The proposal of strategies, that really comes from Maria and Preston, and other utility personnel taking those options, and deciding what is credible in the context of real plant operation.

MARIA KORSNICK: And yes, we did that. We did a formal tabletop analysis, as I highlighted in mine, and it was released yesterday by the BWR Owners Group to Owners Group members, which was the detailed, this is what was done, this was the outcome that was taken. So, pumps that you needed to start, flow that you needed to have, you know, this kind of specific detail.

COMMISSIONER APOSTOLAKIS: Okay, do we have that?

MARIA KORSNICK: It was issued from the BWR Owners Group. I'm not familiar if that goes directly to the NRC, but I would be glad to facilitate conversation with the NRC staff through the Owners Group.

COMMISSIONER APOSTOLAKIS: Now, if we went with Option 4, the staff will need some guidance as to whether this strategy is acceptable or not. So, Option 4 says performance-based approach, although now I think they have changed the title. We don't use that anymore. So that means that they would have to take this strategy and maybe others, develop some performance criteria, maybe similar to the 1,000, the decontamination factor, interact with the industry and other stakeholders, and God knows what else. So coming back to the point Commissioner Ostendorff raised about timeliness, I'm really puzzled by your statement that Option 4 and Option 3 can be achieved in the same timeframe, given that there is a lot of work that needs to be done on Option 4. The ACRS here a month ago told us it would take about a year just to develop the performance criteria, and I don't know what else they will have to do, the staff will have to do. And Commissioner Ostendorff said that, We don't want to have another GSI-191, and Maria I think countered we're not going to need all of these tests, because in 191, you always have that. But we don't want to have another NFPA 805 either.

[laughter]

And when you say, Neil, that it will be a plant-specific thing, well that's a problem, one of the problems in the NFPA 805 that our staff receives now on these plant-specific programs, and analyses, and they have to review each one. So necessarily then you're talking about many years because first of

all each plant will have to develop the strategies, then convince our staff that it's a legitimate strategy. So, I don't think we should consider only GSI-191. I mean there are ways and I think there are very real ways that this thing can go on for 10, 15 years.

But then there is this somewhat concept of defense in depth. And as you know, the staff in its document considers it a significant argument for filters, the fact that one of the major relevance of defense in depth, mainly the containment, is strengthened by the installation of filters. Now, the problem with defense in depth is that we really don't have any guidance how much to use, when to use it, you know. There are some general statements here and there that when you have large uncertainties for example, you do something about it. Now, here you are talking about severe accidents, Level 2 kind PRA, and I don't think anyone can say that the uncertainties are manageable there. I mean there are large uncertainties. So, it passes that one. If I go to regulatory guide 1.174, which actually became a little more exquisite about defense in depth, it says that when you consider whether to put an extra barrier, you should make sure that you don't rely excessively on programmatic activities and human actions. And from what I've heard today, Option 4 does both.

So, given the uncertainties, given this excessive reliance on operators and their actions, and so on, it would seem that I would need to do something about defense in depth. And installing the filters would be a good way of eliminating those, and making sure I resolve this issue within three years instead of 15. Am I wrong in this thinking?

NEIL WILMSHURST: Again, I'd say --

COMMISSIONER APOSTOLAKIS: You may disagree without calling me wrong.

[laughter]

NEIL WILMSHURST: It's a good question, and I'm sure there's many perspectives with the table, and I'm straining to feel where clearly you have a far deeper knowledge than I as an individual do.

COMMISSIONER APOSTOLAKIS: I think flattery works with me.

[laughter]

NEIL WILMSHURST: Remember that our work was not about developing an answer. It was about understanding options. So, and also the final slide said, "Filters are potentially still an option to be worked on."

MARIA KORSNICK: Yeah, I guess I would counter, however that acting like a filter is defense in depth for containment, I struggle with that concept, because the items that we're talking about, I do think provide defense in depth for protecting containment. The concepts essentially behind this are the reliable hardened vent, except I think we need one from a wetwell and a drywell, again, both to impact containment. Additional equipment to put water into a spray header, that's something that's going to give you defense in depth for containment, not a filter. The fact that we would have a pressure control device that has independent power and pneumatics, that is defense in depth for containment. So the concepts around that I agree with your statement, but when you apply it to a filter, I don't follow the logic.

COMMISSIONER APOSTOLAKIS: Well, both you, Maria, and others have elaborated on the extra FLEX equipment, the need to cool the debris, and so on, but let's not forget that the staff doesn't say anywhere, "If you

put in the filters, you don't have to do these things." These things have to be done. You have to be able to cool the debris. So, this extra little thing of putting the filters is really the issue here. We're not saying that you shouldn't cool the debris. I mean you have to, otherwise you have all sorts of other release modes, and so on, mechanisms. So, I think it confuses the issue a little bit to say we are doing all these other things. Yes, and these are good, but you still have to face this issue of, you know, installing the filters or not, and how much radioactivity you are about to release, and with all due respect to the operators, whether that will affect their decision.

And unfortunately, the models we have right now for operator performance, are not sensitive to that level, and we have instances in the past, now again you can argue that we didn't have the procedures, you know, and I think it was Davis-Besse where going to feed and bleed the operators hesitated and there was all sorts of debates. The NRC claimed that they risked the -- hurt the safety of the public. The industry say no, we knew what we were doing, and there was never a resolution, but the fact is that people are affected by the consequences of their actions. And I don't know how to quantify that. I'm over my time, Madam Chairman.

CHAIRMAN MACFARLANE: Thank you. On to Commissioner Magwood.

COMMISSIONER MAGWOOD: Thank you, Chairman. Good morning to all of you. Thank you for your statements today. They were all very informative, very helpful, and it's been a good conversation this morning. Let me follow up on and sort of tag on to where Commissioner Apostolakis left off a bit. This issue of cooling core debris I think is very important. Let me ask -- go to

Maria, and I'll ask the staff this as well, I think, what are currently as within the orders we've already sent out, and the current regulatory requirements, what are the requirements for core debris cooling?

MARIA KORSNICK: We have guidance in our severe accident management guidelines obviously that we would follow, but in the beyond-design-basis scenario that we're discussing under these orders, for example in FLEX, you have no requirement for us to focus on core debris cooling.

COMMISSIONER MAGWOOD: And the FLEX equipment that you're anticipating, some of you have already purchased, and requirements under the mitigating strategies, except for perhaps the 5,000 gallon-per-minute pumps that Preston was talking about at TVA, would those give you the ability to cool core? Would they give you the ability to inject into a severe accident damaged containment?

MARIA KORSNICK: Not as currently written. They wouldn't require that. FLEX was designed for preventing core damage. So it hasn't been looked at in terms of the equipment that would be needed in post-core damage scenarios. So what I outlined in my recommendation as I shared with you was an enhancement, but it's not a requirement that you currently have of the industry.

COMMISSIONER MAGWOOD: So Option 3 unto itself -- Commissioner Apostolakis pointed this out, Option 3 unto itself does not address containment integrity. It doesn't address core debris cooling.

MARIA KORSNICK: That's correct.

COMMISSIONER MAGWOOD: So you would have to do something after that, another order, another rulemaking. There'd have to be something after Option 3, if you were to deal with it.

MARIA KORSNICK: If you want a filter to be effective in all scenarios, it would have to require a containment strategy. That's correct.

COMMISSIONER MAGWOOD: Just wanted to make sure I understood that. Let me, again, appreciate your trudging through the snow or whatever you had to endure to get here. I just wanted to follow. I want to make sure I understood a few things that you commented, you and your colleague commented. Did I understand correctly you did not have a regulatory requirement for filters specifically? You have a performance requirement.

RAMZI JAMMAL: That's correct. There are two things. A prescriptive requirement is you shall have the control of the larger release frequency with respect to one to 10 to the minus six. How we meet those safety goals now? The prescriptive aspect is you should have mitigation measures in order to protect the public. Now, what -- when I said it is performance based, we don't prescribe that you shall contain cesium up to 99.99 percent. So performance of the meeting of those safety goals is by the applicant or the licensee, and then we reviewed its effectiveness from that perspective.

COMMISSIONER MAGWOOD: So does that suggest that if one of your applicants had come back and said, "Yeah, we could install a wet scrubbing filter, but we have this other strategy," you would have listened to that and evaluated it?

RAMZI JAMMAL: We will take into consideration and evaluate it, correct. We don't have -- again the prescribed requirement is you shall have

control with respect to, as I mentioned the Commission has asked us to evaluate the, you know, the failure of mitigation, and if you have failure in your containment, what actions you will take, and what are the design enhancements from a safety perspective that are in place.

COMMISSIONER MAGWOOD: And you approach this on a plant-by-plant, plant-specific basis?

RAMZI JAMMAL: That's correct, well I mean, again it's the nuclear industry, the design of nuclear industry itself is just the nature of it. No two plants are even identical. So, each one has a different radiation. So, the action items arising from the Fukushima, our recommendation is to take into consideration the specific plant design, and putting in place the requirements on plant basis.

COMMISSIONER MAGWOOD: Would it have been easier just to have a -- you wouldn't have made everybody feel better just to have a one-size-fits-all approach, and just tell everybody to do the same thing?

RAMZI JAMMAL: Well, the responsibility of safety really lies with the operator, so we put the requirements in place that they should have to have the control of the release frequency through the safety goals, and then they are responsible to meet the safety requirements. Because we look at it from the perspective is the short-term cost versus the long-term cost of cleanup in case it needs to be taking place.

COMMISSIONER MAGWOOD: Thank you, appreciate that. Let me try Maria. Let me ask you this question. There's been lots of discussion about what the operators would and wouldn't do, and I appreciate the comments that you and your colleague that joined you today have made about what operators would do. And as you can hear there's still some skepticism to what

operators would do in the actual circumstances. Just sort of gratuitous in comments, since I have four minutes and 43 seconds left is just the point that, you know, that highly trained people do things all the time that people don't have those trainings would consider to be extraordinary. You know, people run into burning buildings. You know, people, you know, sit in submarines for months at a time, you know, things that normal people say, "How could you ever do that?" Well, it's what they're trained to do. They're highly trained people. So, I think that this conversation of what the operators would and wouldn't do under highly defined procedural circumstances, I don't think it requires an HRA analysis to do that. I think it's something which is why we have them. That's what we've paid these people to do. This is what they've devoted their careers to.

But one thing that was discussed by the ACRS is the fact that under the severe accident conditions, you're asking the operators to do more things in the case of the performance-based approach. Is the vent cycling, which requires operators to turn vents on and off multiple times over a period of time. Can you -- and if you want to call on your colleague, that's fine as well. Can you talk about what the operator's responsibilities would be during a severe accident, and how vent cycling and some of these other steps would add to the burden of the operator during such a stressful time?

MARIA KORSNICK: Yeah, I'll frame it up. Phil, if you want to get to the podium, just in case you want some follow-up comments, but you know, this is something that quite frankly I asked them to explore when we were doing the tabletop. I said, you know, considerably interested in terms of operator burden, and as we're going through its, you know sort of highlight sort of any issues or challenges with that, and Phil can talk to you specifically about the

guidance that we currently have in our SAMGs in terms of the pressure control and the pressure band that we maintain. And as we went through this scenario, I guess the conclusion was that it's not overly burdensome for the operator, and that we currently have guidance where we have to maintain within a certain pressure band within our severe accident management guidelines. But Phil I don't want to put words in your mouth.

PHIL AMWAY: Okay and I'll pick it up from there. You know as far as the actions the operators would be performing in a severe accident case, we would by that time have exited the emergency operating procedures, and be fully in the severe accident management guidelines. And those severe accident management guidelines do have requirements, and they are for controlling containment pressure in band. It really depends on the specific circumstances that the plant is in whether we -- you know, what band we think it would control that in. There's the pressure suppression pressure, which is a lower pressure at which we would expect the containment to withstand a blow-down. So, we have actions in there to contain -- the containment pressure below the pressure suppression pressure, and other different circumstances, the primary containment pressure limit. The actions would be the same. It's the band at which you would control it, and the strategy is not to open the vent and leave it open. It's to vent as needed, to maintain below one of those two limits, but at the same time terminate the vent to minimize the radioactive release to the minimum possible. And so, throughout the severe accident management guidelines, through the different legs of execution you have specific steps, and they are to provide the guidance for when to vent, and what containment pressure limit you're protecting against.

COMMISSIONER MAGWOOD: So basically you're saying the operators are actively doing things throughout the event, and this might change exactly what they're doing, but it's not going to change the magnitude of the workload?

PHIL AMWAY: The strategy would remain the same and I've have to re-emphasize that if we look at the existing plant design, that action is much more complicated from an operator's perspective than the new proposed design of an order for the reliable hardened vent.

COMMISSIONER MAGWOOD: Okay, appreciate that. I have a few seconds. Now David, I wanted to give you a chance to respond, but also just sort of give me a kind of -- got a lot of respect for you, because I think you take these things very seriously. But I mean hear what these folks are saying. Is it -- or do you see that what they're saying is just invalid or is it just something where there's a lot of unanswered questions that need to be analyzed. How would you characterize that?

DAVID LOCHBAUM: No, there's a lot to it. I'm not saying Option 4 should be thrown out. It just can never -- our concerns are the reliability associated with a lot of the actions. You know, the question you just asked, the operators are currently trained to maintain reactor pressure by cycling the relief valves to maintain the reactor pressure within a band. That's not dissimilar from the proposed task for maintaining containment pressure. The key to both, and the issue more largely, do they have instrumentation available in order to make those calls? If Fukushima was not -- there were a lot of issues. The operators were flying blind. Do we have the instrumentation available under those conditions, the severe accident space, we've lost a lot of D.C. and AC power. Do

the gauges tell them other than they're just downscale? Will they know to make those informed decisions when they need to? I have more doubts about that than their ability, or their willingness, or their desire to do so. Do they have the information upon which to take that step when it's needed, and I don't think all those questions have been answered.

And as I mentioned earlier in an earlier question, because the first recommendation in the near term task force about how to treat beyond-design-basis things isn't nailed down yet. How much credit do you give for some of these actions, because they do rely on the quality of parts, the recurrence of training. Those answers haven't -- those questions haven't been answered yet. So, I don't know how to put weight on those factors, and if I did, it may be that Option 4 is still not good. But right now, I can't give them enough credit to move it ahead of Option 3.

COMMISSIONER MAGWOOD: Yeah, my time is up, but let me just -- I appreciate that last comment. I wanted to thank you for that, because I fully agree with you on that. I think that we need to have dealt with recommendation one before answering this question. The time doesn't always work out ideally when we'd like it and also the economic consequences decision. Those are both decisions that play heavily into this, but I appreciate your comments. Appreciate all of you joining us today. Thank you, chairman.

CHAIRMAN MACFARLANE: Any additional questions?

COMMISSIONER OSTENDORFF: I just have a real quick question, that'd be Maria. It'd be very helpful to the Commission and the staff to receive this BWR Owners Group tabletop analysis as soon as possible, if that's something can be released.

MARIA KORSNICK: Okay, I will work with the owners group to figure out the appropriate way to create that conversation.

CHAIRMAN MACFARLANE: Anybody else?

Okay, thank you all very, very much for your presentations. We will now take a five-minute break before we hear from the staff.

[break]

CHAIRMAN MACFARLANE: Okay, if we can get started. Okay, so, now we will gather again to hear from the NRC staff on the issue of containment vents and filtered vents. So, I'm going to turn it over to the EDO, Bill Borchardt.

BILL BORCHARDT: Thank you, Chairman. Good morning. This is our ninth briefing to the Commission since the accident at Fukushima Dai-ichi. Throughout this, our guiding principles on the implementation of the Fukushima lessons learned are first that we must ensure that we do not distract either our focus or the industry's focus on the continued safe operation of operating reactors. Secondly, in implementing the lessons learned, we want to ensure that we don't displace work that has a greater safety benefit or is necessary for the continued safe operation. And last, while we need to move forward promptly, we need to impose the right requirements.

In our assessment of the issues relating to containment venting in Mark I and Mark II containments, we believe we have adhered to those principles. It was evident from the discussions earlier this morning that there's general agreement of all stakeholders that filtration is important to mitigate the potential radioactive releases from BWR Mark I and Mark II containments. We all want to do the right thing. While there may be differences on exactly what the

additional actions should be, it's important for us not to lose sight on that fundamental agreement. However, very simply, it's the staff's view that in addition to the safety enhancements that'll be put in place by the orders, by future rules that we're working on, and by FLEX equipment, as was discussed this morning, it's the staff's view that it's prudent to require the installation of filters on the containment vents. Also, there's a clear linkage to Recommendation One on the regulatory construct, as we evaluate how or even if current voluntary initiatives, like severe accident mitigation, should be treated in the regulatory space. So, with that introduction, I'll turn the presentation over to Mike Johnson.

MICHAEL JOHNSON: Thank you, Bill. Good morning, Chairman, Commissioners. Today with me are two members of the staff committee of Brian Sheron, who's director of the Office of Nuclear Regulatory Research, and Eric Leeds, who is director of the Office of Nuclear Reactor Regulation. In addition, John Monninger, who is the deputy director of the Division of Operator Reactor Licensing -- Division of Operator -- Operating Reactor Licensing -- good, thank you, John -- will provide a substantial portion of the briefing. I'll provide an overview with respect to Tier 3, the Fukushima Lessons Learned actions, and also I'll provide an overview of the containment venting systems, and then I'll hand it over to John. Next slide, please.

I just do want to note that while we've completed a significant amount of work to prepare for the recommendations today that we'll talk about with respect to containment venting systems for Mark I and Mark IIs, that we have continued a high level of focus on the remainder of the Fukushima Lessons Learned activities. We continue to make strong progress. We've implemented real actions that have resulted in real safety improvements, and those are on

schedule. We received the Tier 1 orders -- status updates on the orders in October, and those indicate that licensees don't have technical issues with respect to responding on schedule with respect to their integrated plans. Licensees have completed their seismic and flooding walkdowns and provided those reports in November. Licensees are implementing corrective actions based on those walkdowns, and we've conducted follow-up inspections and those reports will be provided to the agency very shortly. We'll continue to review those walkdown results and we'll ensure that we take any additional actions -- that licensees take any additional actions that are necessary.

With respect to the seismic and flooding hazards re-evaluations, those are progressing. In addition, we have received comments on the advanced notice of proposed rulemaking. Rulemakings that we've had, that we issued, regarding mitigating strategies and emergency procedures, you know, we'll incorporate those comments, those inputs into our proposed rulemakings. And then, finally, we continue to make progress on Tier 2 and Tier 3 activities. May I have the next slide, please.

We will very shortly provide our next semiannual update to the Commission regarding the status of all of the Fukushima actions. We are continuing to assess also the near-term task force Recommendation One, which deals with a framework and potential changes to that regulatory framework. We're developing options and we'll discuss those options. In addition, we'll discuss the staff's recommendation and recommended path forward. We're currently scheduled to do that in February, although I want to tell you we are reassessing where we are with respect to that Recommendation One paper, and

we may propose a revised schedule to provide additional time. We'll come to the Commission at a later date with respect to that.

Finally, we continue to make progress on the station blackout rule and implementing the Commission's direction that we treat it as a high priority and that we complete that rulemaking within 24 to 30 months. We are scheduled to provide that to the Commission -- a draft proposed rule to the Commission on station blackout in April. Of course, the primary purpose of that rulemaking really is to codify in our regulations the requirements that we've already put in place -- the Commission already put in place when it issued the orders on the mitigating strategies.

Now let me just return to the focus of this briefing, if I can. It's fair to say that our evaluation of the possible improvements in containment venting systems for BWR Mark I and Mark IIs really has been one of the most intensive efforts that we've undertaken in the last year. In fact since we issued -- since the Commission issued orders and 50.54 (f) letters. Following the Commission's direction, the staff has put in tremendous effort to develop a recommendation that you'll hear today. We'll talk about in additional detail today, that is, we've worked diligently with stakeholders and actually point in fact to the fact that many of the folks in the staff who were leaders in the presentation -- in the development of the analysis and the options -- have joined us in the Commission meeting today. I'm very proud of the efforts of those folks.

Our goal was to compile a complete technical and regulatory analysis. We recognize that this is -- consideration of filtered vents is a difficult and a complex issue. We certainly recognize that. I want to note a point that was made earlier in that we didn't start -- I certainly didn't start off with where I

ended up with respect to the recommendation that we provided to the Commission on filtered vents. That is, we didn't start with a desired outcome in mind and then work back and build an analysis to support that outcome. We conducted a thorough and systematic analysis using existing tools, and that is -- formed the basis of the recommendation that we're offering up today.

I also want to note that while we considered -- mindful of international experience, that was not an overriding consideration in the staff's deliberations and the staff's final analysis about what we ought to recommend to the Commission going forward.

And then, finally, I would just note that -- as has been pointed out, there were no stakeholders -- I listened intently on the previous panel. There were no stakeholders who argued for the status quo. That is, everyone of the stakeholders recognize a need for us to deal with the containment's ability to cope with beyond-design-basis severe accident conditions, including the potential for some fission product releases. So with that, I'll stop and let John begin the details of the presentation.

JOHN MONNINGER: Thanks, Mike. Good morning, Chairman and Commissioners. I have the fortunate opportunity to present the staff's results. Like Mike did, I would like to recognize the staff, who's predominantly in the front row. That's approximately 50 percent of the team. And I think you see from the volume of the staff's analysis, it was a significant effort. The effort included the Office of NRR, Research, and NRO, in addition to the significant work by Sandia National Labs.

So I'd like to start off by briefly outlining our approach in addressing consideration of the additional requirements for containment vent systems for

BWRs with Mark I, Mark II containments. We conducted our technical assessment in accordance with established agency processes and procedures for the consideration of new safety requirements. We did that in accordance with our existing regulatory framework to evaluate the options and develop a recommendation for the Commission. We conducted detailed computer analysis modeling and simulation of the various options to inform our assessments and to provide a feeder into the regulatory analysis. Consistent with federal government-wide practices and NRC procedures, we identified various qualitative factors that address issues that are not easily addressed using the quantitative terms in the NRC's regulatory analysis. To gain insights of our stakeholders and to provide a transparent evaluation, over the past year we conducted 15 public meetings. In addition to that, we had five meetings with the Advisory Committee on Reactor Safeguards that were open to the public. In total, we had 15 meetings this past year on this topic. Finally, we developed a recommendation for the Commission based on the best available information available to the staff. Can I have the next slide, please?

The concerns with Mark I and II containments under severe accident conditions has a long history. It goes back to the earliest risk assessments and the earliest severe accident studies. As noted in the task force's report -- the near-term task force report -- the fundamental concern stems from the small volume of the containment. While the pressure suppression containment -- while pressure suppression containment, such as Mark Is and Mark IIs, are able to adequately cope with design-basis accidents, they are challenged under severe accident conditions. And those challenges are focused

in two different areas. One predominantly pressure, but the other for the potential for Mark I liner melt-through.

The limitations of the small sizes of the containments are evident in the high-failure probabilities that have been estimated in the past for the containments if the core damage was to occur. Some of those assessments are as high as 90 percent. The NRC efforts over the years, going back into the 1980s, the severe accident research program, the containment performance improvement program, and efforts to enhance emergency operating procedures, all led to the recognition that venting of the containment and injection of water to the reactor cavity are needed to prevent gross containment failure. The NRC in the 1980s approved emergency operating procedures for venting. However, we never put in place a formal requirement for systems, structures, and components to ensure that that venting function could be accomplished.

The accident in March of 2011 at Fukushima Dai-ichi involved the loss of electrical power and containment cooling. This accident highlighted past concerns with the performance of Mark I containments. There were problems with heat removal from the core, from the containment that resulted in complications in ensuring successful venting. Subsequently, the severe accident conditions in migration of hydrogen from the primary containment resulted in considerable complications in post-recovery efforts. Can I have the next slide, please?

So where are we currently? We have the reliable hardened vent order that was issued in March of last year. The order is focused on prevention of core damage events. However, it does not cover severe accident conditions.

This order was issued under adequate protection provisions of the Commission's requirements. May I have the next slide, please?

So as discussed within the near-term task force report, the accident in Japan caused the staff to re-evaluate the balance between accident prevention and consequence mitigation, and to look at the need for defense in depth measures to address uncertainty. The potential need for improvements following core damage was identified and the staff continues to look for additional lessons learned. One of those additional issues identified by the staff was the need to consider filtration of containment vents. As was mentioned previously, in December 2011, the Commission directed the staff to evaluate that issue as a Tier 1 issue. The staff has done so, and that is what resulted in the paper that we're discussing today.

In addition to that, earlier this year in August, there was a briefing to the Commission on the lessons learned. One of the requests or one of the directions from the Commission was to provide an assessment within the SECY paper of those accident sequences wherein containment venting is beneficial and not beneficial. We have discussed those sequences in the paper, and the staff concludes that filtered vents in conjunction with other severe accident mitigation features, such as lower drywell flooding, are beneficial for the majority of BWR accident sequences. Can I have the next slide, please?

So going forward, we identified four options. Option 1 is essentially the status quo, which encompasses the order for reliable hardened vents. That's order EA-12-050, and that order is focused on the prevention of core damage events. Option 2 essentially involves the upgrading of the existing order or the upgrading of the reliable hardened vent required by that order such that it will

remain functional during severe accident condition. Option 3 is then a progression of that, and it would add or potentially require the addition of an engineered filter to that severe accident capable venting pathway.

As noted within the staff's paper, Option 4, the severe accident confinement strategy, is more conceptual in nature. We identified various alternatives for Option 4 to manage and reduce the release of radioactive materials. One potential alternative is the approach under development by the nuclear industry. However, the staff has reservations with that approach, which we will discuss today.

The staff fully recognizes that whether it's Option 2, Option 3, or Option 4, to be successful a means to flood the reactor cavity must be provided to prevent other containment failure modes, such as Mark I liner melt-through. We explicitly discussed that in the staff's evaluation and assessment. Our analysis assumes that that mechanism, that means to flood the reactor cavity is already required by the NRC's existing requirements within 10 CFR 50.54 (h)(h). That requirement, the industry endorsed a guidance document developed by the Nuclear Energy Institute. There is specific language in that endorsed guidance document requiring provisions for injection of water to the reactor cavity post core damage. As a result, the staff did not include that requirement within this order because we assume that requirement already exists. Had that requirement not already existed, the staff was prepared to add that to the current order. May I have the next slide? The current draft order.

So in our evaluations of the options, as was discussed, we conducted quantitative analysis and we considered qualitative factors consistent with our established process. We performed our technical analysis using state-

of-the-art computer codes, supplemented with the staff's expert engineering judgment. MELCOR simulations similar to those performed for the NRC's state-of-the-art reactor consequence analysis were used to evaluate the plant's response to severe accidents and to evaluate sensitivities to various parameters. These simulations reaffirm past conclusions that a combination of venting and core debris coolability is needed to prevent containment failure. This is consistent with previous NRC studies and the findings that you heard earlier today by previous panels. The staff's analysis shows that venting from the wetwell is preferable. However, our analysis didn't explicitly include the consequences of containment flooding resulting in the loss of the wetwell vent path, and the need to transition to drywell venting. The desire to limit releases associated with drywell venting is an important factor in the staff's recommendation. The engineered filter would supplement the decontamination capabilities of the suppression pool and containment sprays.

So we took the MELCOR results and they were used as an input into the consequence analysis. The NRC's code for doing that is the MAX code. The MAX analysis provides estimates of off-site doses, land contamination, and economic consequences. The result of those showed that public health and safety as estimated by our typical measures was shown to be largely protected by the evacuation of the nearby population. However, the MAX simulations also demonstrated the potential reduction in doses and economic losses that might result from installation of an engineered filter. We also completed a risk evaluation. The risk evaluation led to the conclusion that containment venting, be it filtered or unfiltered, is an important aspect to avoiding hazardous conditions within the reactor building that could impede accident management functions. In

effect, we believe it is important to have the reactor building intact such that post-accident actions can be accomplished. This benefit reinforces the aspects of an engineered filter in the containment venting system, especially if venting directly from the drywell.

Collectively, the MELCOR MAX and PRA analysis supported both a quantitative regulatory analysis and the qualitative analysis. As I mentioned previously, Option 4 was more conceptual in nature, and we provided a range of alternatives. As a result of it being conceptual in nature, we could not and did not complete a detailed regulatory analysis and cost-benefit analysis of Option 4 because there isn't a selected alternative there. Nevertheless, we did conduct a preliminary assessment of the industry-proposed approach. We have briefed the ACRS on our options, on our analysis and our recommendation, and in November the ACRS issued a letter on the staff's evaluation.

Broadly speaking, we believe the ACRS is very supportive of the staff's approach, the staff's analysis, assessment, and recommendation. While in the end, the ACRS recommended Option 4, and we are recommending Option 3, the ACRS fully endorsed the staff's pursuit of additional defense in depth measures for Mark I and II containments, agree with the staff's use of qualitative factors, given the limitations and quantitative analysis, and recognize that filtered vents may be one outcome of Option 4. The ACRS also identified six characteristics of a performance-based approach that we believe is important to mention. Some of those characteristics include keeping containment loads below containment design pressures, not relying upon manual actions, mitigating the potential for overfilling the wetwell, preserving the integrity of the drywell head seal, and addressing hydrogen control. Currently, the staff does not believe that

the current industry approach addresses these characteristics identified by the ACRS. This is one example of the staff's concerns and raises doubts in our mind as to whether the technical issues associated with Option 4 can be resolved within a reasonable timeframe. Regarding the engineered filtered vent system, the staff believes it does meet all the characteristics identified in the ACRS letter. Can I have the next slide, please?

As I mentioned, the previous slides discussed our technical analysis, and they provided an input to both the quantitative and qualitative evaluations. In our cost-benefit and regulatory analysis, the staff concluded that Options 2 and 3 represent a substantial improvement in public health and safety as required by the NRC's backfit rule. As a result, we proceeded to conduct the cost-benefit analysis. We also performed various sensitivity studies to changes within assumed parameters. The net value of both Options 2 and 3 are negative at the assumed event frequency of two times ten to the minus fifth, which the staff does believe is representative of reactors with Mark I and II containments. However, if the event frequency is assumed to be in order of magnitude higher, the severe accident capable event is cost beneficial while the engineered filtered vent is marginal. May I have the next slide, please?

As I mentioned, the NRC's regulatory analysis guidelines encourages quantitative analysis whenever possible. The guidelines also recognize that some factors cannot be easily quantified and the analysis needs to consider qualitative factors as well. Accordingly, we identified various qualitative factors for consideration. It's important to recognize that we don't view all the qualitative factors as being equal. Some are much more important in the decision-making process. We believe that the high potential failure probability of

Mark I and II containments should be addressed and that an appropriate balance between accident prevention and consequence mitigation should be provided. In looking at that, we believe the best solution for doing so is the installation of the engineered filtered vent system. We believe such a system would significantly reduce releases and provide source term mitigation largely independent of a plant's response. Can I have the next slide, please?

This slide lists the various qualitative factors. The relative importance in making the decision is a matter of judgment by the analysts and by the Commission as the decision makers. While some of the factors argue for not pursuing any improvements, the staff believes the majority of them provide support for some level of improvements for the performance of Mark I and II containments. While recommending a different option, the ACRS agreed with the qualitative factors, primarily improving defense in depth. The staff sees more benefits in Option 3, which is the recommendation for an engineered filtered system. I'll address several of the factors on the next slide. However, one of the qualitative factors out there, which the staff hasn't included on the slide, is the timely resolution of safety issues. It was discussed in earlier panels and was indicated that it could potentially be completed in the same timeframe as Options 2 and 3 or even potentially earlier.

We reflected upon NEI's letter dated October 5, 2002, and came to the belief that it could be potentially significantly protracted. NEI mentioned in their letter that applying the findings of that brief study to individual plants as was discussed earlier, will take significant effort and time. The initial steps discussed were viewed as lasting at least 24 months, including having each plant perform a plant-specific evaluation based on the EPRI methodology and reaching

alignment with the NRC staff on the performance basis, the development of regulatory vehicle implementation guidance, design basis assumptions, severe hazard considerations and other factors.

Following that, they indicate that an additional significant amount of time will be required to perform the required analysis, engineering, design, development, procurement, plant walk-downs, installation, testing, and training.

The staff believes that performing such plant specific severe accident analysis, developing custom engineering solutions, and resolving the associated technical issue, will be a significant undertaking unlikely to resolve the issue at hand in a timely manner. Complicating this assessment was the view that further consideration of potential off-site releases from severe accidents should be considered concurrently with near term task force Recommendation 1, the risk management task force report, and consideration of economic consequences in land contamination. The staff notes that filtered vent technology currently exists and there's a proven track record of approving and installing filtered vents within a reasonable timeframe. May I have the next slide, please.

So within this slide and within the paper I'll try to summarize the pros and cons. We'll center on Options 3 and 4 because that's where it appears that the differences are. Regarding Option 3, first and foremost, the staff believes an engineered filter would enhance defense in depth for the containment barrier. It would significantly limit the release of radioactive material should venting be necessary and would provide more balance in accident prevention and consequence mitigation. In addition, we believe that an engineered filter provides certainty in capturing radionuclides and therefore

provides assurance that on-site accident management measures and personnel actions will not be unduly impacted or delayed as a result of containment venting.

A filtered vent also allows containment pressure to be reduced to low levels. This significantly reduces the pressure differential across containment penetrations and seals. As such, the staff believes the filtered vent would substantially address hydrogen transport and leakage from the primary containment to the reactor building and any subsequent concerns for hydrogen explosions within the reactor building. This would facilitate on-site operations to mitigate the accident using installed equipment and instrumentation within the reactor building.

Following a severe accident, the reactor coolant system and the containment are integrally connected. The source term from the severe accident is dependent upon many factors, including the sequence you're in, the timing, removal mechanisms within the reactor coolant systems within the containment hold-up plate-up deposition. It’s dependent upon the pressures, temperature, chemistry. As a result, the staff believes there is considerable more uncertainty associated with fission product removal strategies that directly rely upon the conditions in the reactor coolant system and the containment and that an engineered filtered vent system is largely independent of those factors. As such, we believe a filtered vent provides a high level of certainty that a desired decontamination factor will be achieved.

While recognizing that some operator actions are needed, we also believe that passive measures can have an important role. This was also reflected in the ACRS letter wherein they indicated their preference for reliance on passive components and minimizing manual actions. We also believe that

during the August briefing to the Commission, the Professional Reactor Operators Society expressed concern about the impacts of training on licensed operators. As such, we believe there are merits in the passive aspects of an engineered containment venting system.

Regarding the industry's approach on filtering strategies, it largely relies upon existing severe accident management strategies and plant equipment. The major new concept is associated with cycling the containment valves to try to maximize the fission product removal efficiency. We do have technical issues associated with this approach. We are not aware of any testing or data that supports the benefits of that. In addition, we did analysis of that using the NRC's MELCOR code and we saw minimal if any benefit from cycling event valves versus once opening venting. The strategy also relies upon keeping the containment elevated for significant amounts of time. We believe that doing so challenges containment penetrations and seals and does not necessarily address issues associated with hydrogen transport from the containment to the reactor building. Earlier it was mentioned that event cycling would occur within the first 24 hours, approximately six to eight times. While that is true when you look at the EPRI analysis, I think it's important to look at the rest of the analysis. Eventually, drywell sprays have to be turned off because of the level within the containment. If you look at the analysis then, at 48 hours it has containment vent cycling approximately once an hour. And at 72 hours you have the containment pressure at 70 pounds of pressure absolute and 300 degrees Fahrenheit. So it is true that within the first 24 hours the analysis has cycling approximately six hours. But there's more to the analysis than that.

Another fundamental aspect of the industry approach is reduced water flow to the containment sprays. For years there's been issues associated with credit for BWR, Mark I and IIs for fission product removal due to sprays. It's a significantly reduced flow rate. In addition to that, it's a very crowded containment. As a result, the staff is not confident that there will be testing or data to support the removal of fission products -- significant removal of fission products from the Mark I and II containment atmosphere. We believe these various technical concerns will have an impact on schedule and resources and there's no guarantee that the resolution will demonstrate the needed performance of these strategies. May I have the next slide, please, the last slide.

So as discussed during our presentation, we believe there are considerable difference in the options under consideration, and in the certainty to which those options would address the performance issues of Mark I and II containments. We believe the technology associated with engineered filters has significantly advanced over the past 20 years and we believe there is confidence that a near term solution exists with that. Based on our technical evaluations of jointly the quantitative and qualitative factors, we are recommending Option 3, which is the installation of engineered filtered vents.

Going forward as discussed in the paper, if the Commission was to approve either Options 2, 3 or 4, the staff would as appropriate engage stakeholders on the draft orders to assess any possible implementation issues. Subsequently, we would inform the Commission of the results of those interactions and provide the final order via regulatory notification. This ends the status presentation. I look forward to any questions you may have.

CHAIRMAN MACFARLANE: Okay. Great. Thank you very much. That was very, very informative. We will start off with questions and we'll start with Commissioner Ostendorff.

COMMISSIONER OSTENDORFF: Thank you, Chairman. Thank you all for the presentations today. I also thank the staff in the well and I know that a lot of people here and some not here, have worked extraordinarily hard on this and so we're very grateful. I know that this is a very complex set of issues and I want to get to some regulatory questions for Mike, but before I do that I want to make sure I was clear of one thing with John. And I know that there was a lot of time spent at the first panel, talking about the importance of keeping any core debris resulting from a severe accident cooled. I know in your Slide 9 you addressed this issue and I just want to make sure that I had this completely straight and that you completely agree with the industry presentation that core debris cooling is absolutely essential and the containment integrity strategies are essential. Those are already required and that your filter recommendation is separate and distinct from those first two points.

JOHN MONNINGER: Yes.

COMMISSIONER OSTENDORFF: Do I have that correct?

JOHN MONNINGER: Yes. Well it means to flood the cavity whether it's actually cooled or not. There's --

COMMISSIONER OSTENDORFF: I bring it up because it's my personal perception has been perhaps there has been some confusion in this area and that there's been some very well intentioned but perhaps asymmetrical discussions where there's been a little bit of talking past each other. There have been some perhaps discussions that the staff paper does not reflect the need for

continued core cooling and debris cooling in the event of an accident and I just want to make sure that that is still very much the case in your articulation of strategies plus the filter recommendation.

JOHN MONNINGER: Yes. And we can provide the references to the endorsed guidance documents.

COMMISSIONER OSTENDORFF: I think that would be helpful. Thank you. Mike, I'm going to ask some questions of you and I'll also defer to your call and other people chiming in here. I'm going to put on my regulator hat here and look at the regulatory stability and precedence and future implications of any Commission decision. So I think that's really important.

I recognize and I think the staff paper does a nice job and John did a good job of briefing the different qualitative factors that are considered in the staff recommendations to support the Option 3. Should the Commission, however, have any concerns or nervousness on this use of qualitative factors and the costs justified safety enhancement. Is there any precedent for Commission decision-making that would highlight prior use of qualitative factor considerations?

MICHAEL JOHNSON: Thanks, Commissioner. My perspective on that is that there is past precedent for consideration of qualitative factors. The Commission obviously had to rely on qualitative factors for example for the emergency preparedness regulation, an area that obviously would necessitate that. We looked back, in fact, and John can talk to specifics -- we looked back for example at the AP600 rulemaking, for example, in terms of how the staff considered qualitative factors and raised those for the Commission. The Commission ultimately considered qualitative factors so there is precedent.

But moreover it's consistent with the guidance that we've gotten from the Commission with respect to how we decide whether or not a cost justifies safety -- significant safety improvement can be done consistent with that guidance. Now I know there is nervousness about the use of qualitative factors because, again, that does introduce a level of judgment of consideration, if you will. But in this case, we think it provides an overriding consideration for moving to the right answer, so, but we think we are within precedent.

COMMISSIONER OSTENDORFF: Bill, I'm assuming you agree with that.

BILL BORCHARDT: Yes I do. I mean, there's no question that the Commission has the authority and the ability to do it. It has been done before and I think in increasingly fewer instances I mean the backfit rule and other provisions of our regulatory process try to apply some regular predictability to it. This maybe operates a little bit counter to that, but we haven't had an accident like Fukushima before either.

COMMISSIONER OSTENDORFF: Okay. Let me stay on the same theme and then go back Mike to you and let's talk about the March of 2012, let's just talk about two of those orders, the mitigating strategies and the reliable hardened vents for the BWRs. And those were per the Commission SRM issued as orders needed to ensure adequate protection. This SECY paper for filtered vents is not premised on adequate protection.

MICHAEL JOHNSON: Correct:

COMMISSIONER OSTENDORFF: So here's the devil's advocate question: why an order, why not a rulemaking? Did you consider the steering

committee, the JLDs consider a rulemaking as an approach for this to enhance the stakeholder engagement or --

MICHAEL JOHNSON: Well we -- to be quite honest, I think our consideration with respect to the vehicle, it being an order, really related more to our sense of urgency with respect to timing of getting these requirements in place. So, for example, we thought it was important -- the Commission thought it was important to have reliable hardened vents and ordered it, we'll come back and make that -- we'll codify that in a rulemaking. The Commission thought it was -- had a sense of urgency with respect to the mitigating strategies order. And so, in fact, we issued an order -- we'll come back and issue a rulemaking. Ultimately, we would come back and make this generically applicable in a rulemaking also. But I think our sense was as we looked at this issue, even though we didn't get to the point where we were ready to recommend to the Commission that this would be done under adequate protection, we felt as though moving forward there is -- this is a Tier 1 item in that context that orders were appropriate. And I can let Eric and Brian weigh in.

COMMISSIONER OSTENDORFF: Eric?

ERIC LEEDS: Thanks Mike. Yeah, Commissioner, I think that we were also very mindful that we already have an existing order for a reliable hardened vent and certainly depending on your decision, you know, we didn't want to just leave that out there without having made a decision because this obviously would impact that.

COMMISSIONER OSTENDORFF: Myself, I just think, you know, that from a regulatory philosophy standpoint, orders were issued 10 months ago to go do X based on adequate protection. And this is a different issue, Y, not

based on adequate protection and I think we need to just fully discuss the different rationales for what regulatory vehicle might be appropriate for whatever Commission decision on this.

BILL BORCHARDT: The way it makes sense to me and I'm not on the task force, right, but is if you're going to do rulemaking, you're talking two or three years. Then the implementation date is going to be some time in the future from that. So we're looking at a fairly protracted schedule I think before you actually have physical changes in a plant as a result of what you want to have improved.

MICHAEL JOHNSON: And I ought to have made a point when I talked initially and John can weight in, we have thought about, for example, if the Commission chose Option 4, that typically when we do something that looks like an Option 4 where it's performance-based where you've got to do work, we believe considerable work, in terms of identifying the criteria and all of those kinds of things that you need to do, that that does lend itself to rulemaking. So if the Commission were to say do Option 4, you know, we have thought -- discussed that maybe that would be more appropriate for rulemaking as opposed to an order. But our recommendation was for Option 3 and an order to implement linked to the other order that is already out there in place.

COMMISSIONER OSTENDORFF: Okay, that's very helpful. Thank you. Brian, I want to ask you several questions. If you want to add in on this one.

BRIAN SHERON: Yes, I was just following Eric, I seem to recall that when we were -- the steering committee was discussing this, the adequate protection was, you know, an option in the sense that one could actually make an

argument, okay, that you could rationalize the filtered vents with an adequate protection argument. I won't go into the detail on it. I mean, obviously adequate protection has been defined as you presumably meet the regulations and there's no undue risk and it's the second part that would come into question. And I think the -- where we're coming on it is the fact that, as you heard before, you have a lot of prevention. In other words, you can do a lot of things to prevent the core from melting, but once you have a core melt, this containment is likely to fail, okay? There's very little margin for mitigation. And so I think that's where we were coming from. But, I think the balance, you know, the steering committee felt, was that we would go with the cost benefit. But, again, there could be an adequate protection argument made.

COMMISSIONER OSTENDORFF: And you're saying that was vetted in your steering committee deliberations.

BRIAN SHERON: Yes. Yes.

COMMISSIONER OSTENDORFF: Okay. I'm out of time here. Thank you very much. Appreciate it.

CHAIRMAN MACFARLANE: Thank you. All right, I want to thank you guys very much for all your hard work. I know that you have worked long and hard on this issue and considered it very carefully and I appreciate your analysis. I also appreciate, Mike, you acknowledging that there has been no discussion of Option 1 and I think that speaks to both the NRC and the industry for acknowledging that clearly there needs to be more thinking on this. It's a very serious issue and we need to take it seriously.

There's been a lot of stress over the question of quantitative versus qualitative, which I find fascinating from my seat as a scientist, but also as a

social scientist somewhat practitioner. As a scientist, clearly I'm a big fan of numbers and data. That's always nice to have. But it seems to me that when one makes policy decisions, these are clearly often qualitative decisions so, again. And I note that in terms of the cost benefit analysis, quantitative analysis, the issue is actually settled if you accept one core damage frequency versus the other. And the core damage frequency itself, from my understanding, correct me if I'm wrong, is an entirely theoretical construct based on the number of assumptions, et cetera.

It seems to me that in your cost benefit analysis there were probably inputs that may have been expert opinion or the value of a human life. Are these quantifiable? Expert opinion is opinion. It is a qualitative factor rendering your apparently quantitative assessment qualitative. So I just don't understand really the stress over the qualitative versus quantitative. I don't have a probably with that.

So, sorry, long commentary there. Not much of a question. So let me actually ask some questions. Help me to understand this a little bit more. What's the difference between what the industry is suggesting versus what's already required under 10 CFR 50.54, hotel, hotel.

JOHN MONNINGER: So, core material, either in-vessel or ex-vessel, needs to be cooled and you do that with water. The concern or the potential disagreement is associated with whether there is an existing requirement to provide water to the reactor cavity or not. The staff and we discussed this within our group. We looked at 50.54(h)(h), which was put in place post-9/11 and resulted -- as a result of the B.5.B orders and it endorses industry guidance document developed by NEI and there's an explicit section

within there that talks about water of -- I'm not sure if it's 300 gpm or 500 gpm -- to be provided to the reactor cavity for core debris cooling. So recognizing that, we did not include that within our current requirements. There was debate amongst the group whether we needed a stronger footprint. And we said, "Well no, if it's there, it's there." You know, we don't need a stronger footprint. But then the staff also said, "If there is an eventual follow-up rulemaking, the significance of it is so important that maybe as opposed to being a thread through 50.54(h)(h), a guidance document, et cetera, maybe it warrants a specific place within 10 CFR. But it was actively discussed amongst the team and there's a good reference to it and we'll provide that reference.

CHAIRMAN MACFARLANE: But is this what the industry is --

JOHN MONNINGER: We raised that during public meetings. We stated it at the ACRS meetings. And we had no objections to that. We -- it was point blank one of our assumptions and there has been no feedback that our assumption is incorrect.

CHAIRMAN MACFARLANE: And so I think Commissioner Magwood was getting at this during the last session, but is it possible that in your view what we actually need or may need is both the filtered vents and these severe accident strategies.

JOHN MONNINGER: Yes.

CHAIRMAN MACFARLANE: So it's Option 4 and Option 3?

JOHN MONNINGER: There will be a diminishing, you know, returns that we can justify. You know, a lot of this stuff is within the consideration of the severe accident management guidelines. There's a lot of options. There's

a lot of strategies within that can be taken. The question is where should the regulatory footprint be and what's exactly required.

CHAIRMAN MACFARLANE: Okay.

MICHAEL JOHNSON: Chairman, can I also make a brief point. I think it may be as a part of the discussion of the last panel there was some notion that Option 3 was a filtered vent. It was a single -- you just put a vent -- install a vent -- and not do all of the other things that you do, that are currently done incidentally with respect to managing a severe accident. The installation -- the decision -- the Commission's decision with respect to this vent -- for this filter -- does not obviate the need for severe accident management. Those things would happen. It would be -- you would need to spray. You would need to accomplish this requirement to cool the debris. Option 3 is also an integrated approach to resolving the problem.

CHAIRMAN MACFARLANE: Thanks. That's helpful. So help me understand what your sense is of the technical maturity of Option 3 versus what some of the industry is proposing in Option 4.

JOHN MONNINGER: Right. So for Option 3, the main aspect of it is an engineered filtered vent. So we did significant research of the literature out there. We visited several foreign countries to see the filtering technology, the considerations that went into it, the difficulty of detail, the cost, impact of operations, et cetera. We also had public meetings with at least three if not four different vendors. We wanted to assess the state of the technology.

CHAIRMAN MACFARLANE: So there are vendors who make filters.

JOHN MONNINGER: Right. We, of course, would not endorse any particular vendor.

CHAIRMAN MACFARLANE: Obviously.

JOHN MONNINGER: But the technology has significantly advanced over the years and we believe that there are technical options out there available.

CHAIRMAN MACFARLANE: And compared to alternatives in Option 4?

JOHN MONNINGER: Well the concern with Option 4 is the uncertainty. The two big things are the cycling of the valves and the reduced spray through drywell sprays. All the other things within the industry-proposed approach are existing SAMG measures. The cycling of the valves, we are not aware of any data or testing. In our independent analysis using the MELCOR code did not show much benefit at all. The issue with sprays for drywells for Mark I's and II's, it's an extremely cramped containment. And in addition -- and for your sprays, you need --

CHAIRMAN MACFARLANE: So there's no direct line access --

JOHN MONNINGER: Right. And it needs to fall through the atmosphere and interact with the fission products. In addition to that, the flow rate is approximately 10 percent of design. You need a delta p across the nozzles to produce the small droplet particles of the sprays to interact with the fission products. So we have also asked for data on sprays, spray performance for Mark I's and II's and have not been provided with any information.

CHAIRMAN MACFARLANE: It sounds like this can get pretty complex in terms of fluid flow, fluid dynamics in terms of trying to understand

where you would -- where the radionuclides might go and where the water might go, et cetera.

JOHN MONNINGER: It's different.

CHAIRMAN MACFARLANE: Far beyond my mathematical capabilities.

JOHN MONNINGER: It's different for large dries. You know, this issue with the staff and containment sprays is a historical issue. It's different for the large dry containments and sprays for them.

CHAIRMAN MACFARLANE: And would you require testing or actual data to -- if Option 4 was selected -- to make a decision?

JOHN MONNINGER: We just require them to demonstrate. How they decide to demonstrate it, whether it's codes analysis, et cetera. But the proof is --

CHAIRMAN MACFARLANE: Right.

JOHN MONNINGER: -- they may end up having to do that. But in the end, that's their decision.

CHAIRMAN MACFARLANE: Okay. Okay. That makes some sense. Okay. Well let me stop there and turn it over to Commissioner Svinicki.

COMMISSIONER SVINICKI: Thank you and I thank everyone for their presentations. Bill, you mentioned something in your opening comments that raised a question in my mind. I think I took a careful note here. You said there's a clear linkage in the issue that we're discussing today. So you said there's a clear linkage with Recommendation 1. Mike Johnson mentioned that I was already aware that the staff is currently -- well these were Mike's words this morning. "We are reassessing where we are on Recommendation 1." So the

question that brings to mind for me is if there's a clear linkage between this issue and Recommendation 1, what did the staff assume about the Commission's outcome on Recommendation 1 that is underlying their analysis and recommendation in the filtered vents paper?

BILL BORCHARDT: I don't think we did make an assumption about the Commission's decision on Recommendation 1. All I was trying to refer to was that just as John was just talking about, the severe accident management guidelines, which are now an industry initiative type of activity, they're not required by regulation, whether -- if the decision were to bring those into the regulatory footprint, that there -- as Mr. Lochbaum was talking about in the first panel -- you would have a different degree of confidence perhaps if you changed any of the pedigree requirements for the equipment or not. It all interplays at least in my mind as to the confidence that the equipment is available, operable, has been tested, all those things fall into play whether there's a regulatory requirement or conversely, if it's an industry initiative.

COMMISSIONER SVINICKI: Mike, did you want to add something?

MICHAEL JOHNSON: Yes and I just wanted to add also that we, absent Recommendation 1, have made decisions about, for example, treatment. The Commission made a decision with respect to beyond design basis and whether that should be a requirement, for example, for the mitigating strategies or so. We can figure out -- we'll figure out regardless of whether it's Option 4 or Option 3, what the appropriate treatment is, not waiting on Recommendation 1. But having a Recommendation 1 stamp on the process from the Commission

would have made this maybe be more systematic, it was, I think, a point to be made.

COMMISSIONER SVINICKI: So it sounds like you did have to, because of the linkages to some of these details, you had to make some underlying assumptions about where we would come out on Recommendation 1.

MICHAEL JOHNSON: Yes.

JOHN MONNINGER: I think what the staff did was we assess the options currently consistent with the existing regulatory processes and procedures and developed that recommendation as such. We did not presuppose where Option 1 or where Recommendation 1 would or would not come out. So we believe the analysis or the analysis was done within our existing regulatory framework.

COMMISSIONER SVINICKI: So although you had to address some of these underlying issues and perhaps make assumptions, are you indicating that it was not a discriminator amongst the options in the end in terms of your recommendation?

JOHN MONNINGER: Yes.

COMMISSIONER SVINICKI: I believe it was after Three Mile Island, but the history doesn't matter, in our regulations currently in Section 50.54(x) we have, of course, the provision that allows licensees -- well, specifically with the approval of a licensed operator or certified fuel handler -- to take those actions necessary that depart from license conditions and technical specifications if the action is immediately needed to protect public health and safety and that there's no action consistent with those license conditions and tech specs that would allow them to have the equivalent protection that's

immediately apparent to them. Are there any -- other than this provision, are there other regulations that we have that would have as the regulatory basis lack of confidence or concern that operators will take the actions that are necessary in the circumstances. It seems to me this provision, of course, was put in place to make explicit that if they need to take an action, then they have. There will not be a subsequent fault-finding and retribution for them having taken some sort of reasonable action even if it were differentiated or was outside of license conditions or technical specifications. I can't really, and my staff, nothing else could really come to mind there. And I guess underlying the question is if we have a fundamental lack of confidence of licensed operators doing what needs to be done, don't we have a bigger problem than filters?

BILL BORCHARDT: Well, 50.54(x), I believe, is the only provision in the regulations that's like that. But I would say from my experience, from my time at a number of sites as an inspector, I have complete confidence that the entire operating crew will do whatever they need to take the right action. I don't believe that there would ever be any hesitation to do what's in the best interest of the safety of the plant. So they see it, they train on it, they talk about it, the resident -- NRC resident inspectors understand it, there's not going to be a regulator in the control room challenging them to say, "You know, you're violating the tech specs." They're the best qualified people to make that decision.

COMMISSIONER SVINICKI: Eric would you like to add something?

ERIC LEEDS: If you don't mind if I can add. Typically that isn't where the problem comes in. The operators are going to do what they're trained to do and they're going to try to take the right actions. The majority of the time

they're set up to fail. They're set up because the engineering department didn't do a good job engineering the system for human factors. The maintenance department took their time about changing out that indication. Somebody put a Band-Aid over something that needed a long term fix. Those are the problems that we've seen out in the field that set up the operators to fail. That's why I think this issue is so important to provide the operators the tools they need to make sure that they can succeed, whether it's Option 3 or Option 4.

COMMISSIONER SVINICKI: Okay. And I appreciate that again. I would hate to see what -- in looking at Option 3 and 4, I would hate for it ever to be perceived that the NRC had some kind of underlying lack of confidence and that that at the end of the day was a differentiator between these two options. I think that the factors that will differentiate between the two will be very different than that and so I appreciate you all being very, very clear on that point.

I noticed in the staff presentations today there was -- when outlining concerns about the industry approach and/or Option 4, which I realize the staff made some distinction there -- there was a discussion about the time that it would take to implement the performance based option and I was listening to the list of things that would need to be done. And again, this is a concern that the staff has. It says each staff would have to perform -- each plant would have to perform an evaluation and then they'd have to reach alignment with staff. We'd have to have a performance basis development of a regulatory vehicle implementation guidance, design basis assumptions, hazard considerations. We would need to follow that with the development of the required analysis, engineering design, development and procurement, plant walkdowns, installation testing and training. It seems to me first of all a lot of those things have to be

done under Option 3. There isn't really anything that's going to be installed at a nuclear power plant short of maybe, I don't know, something new in an office environment or something like that that isn't going to require all these steps.

And so it's hard not to hear that and think that there's just an overall frustration in the complexity of regulating, which I'm kind of thinking to myself, do these people need a vacation? Have we burned people out? What's going on here? Because most issues that we have, if we approach it in a risk-informed, performance-based way, this is our bread and butter. This is what we have to do for everything. So I was thinking too on the -- when I was briefed by the staff on the order for spent fuel pool instrumentation prior to the Commission voting on that, I joked with the staff that presented to me. I said, "Now you're getting awfully close in this order. You've got everything short of order Acme model x, y, z, spent fuel pool instrumentation, get the blue one and install it, you know, on this particular location." But that is always going to be easier to do, isn't it, as a regulator to do it -- to tell them to buy Acme model x, y, z filter and just install it in this way. When we go performance-based and risk-informed, the complexity of our work always increases. Do you agree or disagree with that statement?

MICHAEL JOHNSON: Commissioner, we agree with that statement. We agree that and we don't want to be seen as arguing against performance-based risk-informed regulation. That's not where we are. I just want to point out to you that all of that description about was needed wasn't something that we made up. We were quoting --

COMMISSIONER SVINICKI: I agree with it. I have no argument with it either.

MICHAEL JOHNSON: We were quoting from the NEI letter that talked about the next steps in terms of what would be required to implement Option 4. Our perspective I think is that many of these steps are simpler actually with Option 3. Again, the technology is one that we've seen demonstrated, the uncertainties are fewer. So I -- and we're not -- these are the right steps. We think the industry got it right in terms of what they laid out in terms of the timeline. We differ perhaps or at least today I was interested to hear that they think it is much shorter than what initially they thought that time line would mean in terms of --

COMMISSIONER SVINICKI: And I respect differing views on that. I think that that's the only people who will have perfect knowledge of those durations are going to be our successors, who will look back on this and know the truth if that's the option that we pursue. If it's not pursued, then we'll never know. But I think if we're back to use the word "simpler" and that, you know, again, I think we acknowledge that many of the steps will be the same whether it's Option 3 or Option 4. If we start valuing simplicity, I would posit that that is an argument against risk-informed performance-based regulation because it is simpler to be prescriptive. And I think that as a general matter, that is true. If you're valuing simplicity, Option 3 is clearly favored. I agree with that and I'll let you weigh in but I'm over my time so the Chairman is being indulgent here.

MICHAEL JOHNSON: Thank you Commissioner. I -- we didn't pick it because it was simpler. We picked it because we thought it was the best approach. And I think it does turn out though that a number of these steps actually can be done more expeditiously as a result of that particular choice for a number of reasons.

CHAIRMAN MACFARLANE: Commissioner Apostolakis?

COMMISSIONER APOSTOLAKIS: Thank you. John, in your slide 14 -- well first of all, I thought the SECY paper and especially the enclosures were a great document. I really enjoyed reading it. It was very informative, not just giving arguments for the present issue, but also giving good historical perspective. That was really great. Appreciate it.

On Slide 14, you say that Option 4 addresses fewer accident scenarios than Option 3. Would you please elaborate on that?

JOHN MONNINGER: Well some of the considerations there for that is the pathway. For example, Option 3 with the engineered filtered vent, you could have it for drywell venting all the time. You could have it such that the, you know, there's a difference between a LOCA and there's a difference between the station blackout and where the fission products go and the removal efficiencies. So there is a linkage between the performance of systems that are based on the reactor coolant system and the containment versus something that we believe is fundamentally independent of that. We believe that the effectiveness of the vent cycling or the drywell sprays, the suppression pool, is very sequence-dependent. I mean, it could vary and it will vary. You can, of course, try to bound it.

COMMISSIONER APOSTOLAKIS: But you say fewer accident sequences. So you are -- they are leaving some out?

JOHN MONNINGER: You know, I'd have to go back to, you know, refresh myself with the actual write up --

COMMISSIONER APOSTOLAKIS: If you want to send us --

JOHN MONNINGER: You know, within the --

COMMISSIONER APOSTOLAKIS: -- a note later that'll be fine. That'll be fine. Regarding the timing, when we talked about it with the previous panel of GSI-191 or NFPA-805. An important question is and I think you touched upon it, will they -- and the Chairman asked a similar question -- will there be a need for actually testing? And you said, "No, all we care about is for them to demonstrate to us --

JOHN MONNINGER: Right.

COMMISSIONER APOSTOLAKIS: Do you think that demonstration can be done purely analytical, analytically? You don't have to say yes or no, but is there a higher probability that the staff will require some testing and any time you are doing tests, there is a significant delay. That's really the thrust of this.

JOHN MONNINGER: I -- you know, the vent cycling is probably a little bit easier to resolve than the containment sprays.

COMMISSIONER APOSTOLAKIS: Right.

JOHN MONNINGER: There is a very long historical record on concerns with containment sprays and decontamination within the atmosphere. I think I would go on a limb and say for containment spray decontamination factors within the atmosphere for significantly reduced flow rates, existing nozzles, et cetera would result in the need for testing. Cycling the valves? You know, maybe they do it through analysis. Cycling the valves, you know, a lot of it is associated with the phenomena of taking a huge charge through the suppression pool. It's associated with the timing and allowing more time for played-out deposition and hold-up. So there may be a resolution, you know, to the site.

But the other thing is, and it goes back to holding up the containment pressure. You know, containment pressure, while we agree it's good to have the source term in there, what is happening to the containment penetration and seals, what is happening to the hydrogen? You know, I think that is a significant issue that is currently not addressed.

COMMISSIONER APOSTOLAKIS: Now in the -- in one of the briefings that I had with you, or maybe the only one I remember, I asked you whether you're aware of any -- I asked Eric as well -- of a specific strategy that has been proposed. And you said no.

JOHN MONNINGER: Yes. Because you only allow us "yes," "no," within your office.

[laughter]

That was the only option. Yes or no.

[laughter]

I tried it once.

COMMISSIONER APOSTOLAKIS: Want to revise your answer?

[laughter]

JOHN MONNINGER: The EPRI --

COMMISSIONER APOSTOLAKIS: Let him tell you what the thrust of my question is. Ms. Korsnick, today, talked about what -- and she said actually they had a table-top exercise, would you say that that is a proposed specific strategy that is worth evaluating?

JOHN MONNINGER: It's work industry is doing. The EPRI report was never submitted to the NRC. We got the EPRI report from the website. We reviewed it. We were never asked to review it. We have a five or six page letter

from the Nuclear Energy Institute. If you want to believe that that is the strategy --

COMMISSIONER APOSTOLAKIS: No. The question is you were here when Ms. Korsnick --

JOHN MONNINGER: Yes.

COMMISSIONER APOSTOLAKIS: Would you say that's a strategy?

JOHN MONNINGER: We believe they are trying to develop strategies. There's --

COMMISSIONER APOSTOLAKIS: That's why I want you to say yes or no.

[laughter]

JOHN MONNINGER: The EPRI --

COMMISSIONER APOSTOLAKIS: Dancing around.

JOHN MONNINGER: The EPRI --

CHAIRMAN MACFARLANE: I see now.

JOHN MONNINGER: The EPRI approach allows various options and it ends with the notion you can still add a filter. So any -- it's all in there.

COMMISSIONER APOSTOLAKIS: Let me take another approach to this. You said that cooling the debris --

JOHN MONNINGER: Yes.

COMMISSIONER APOSTOLAKIS: -- is already in the books someplace. So you didn't have to say that explicitly in Option 3.

JOHN MONNINGER: Yes.

COMMISSIONER APOSTOLAKIS: Did Ms. Korsnick say anything about their strategy in addition to cooling the debris that is not now in the books and perhaps if we go with Option 3 the industry will not do it? In other words, are there any advantages to the strategy that Ms. Korsnick proposed that maybe we would lose if we go with Option 3?

JOHN MONNINGER: Not that I can think of. They did bring up the issue or concern with hydrogen and the ingress of hydrogen within Mark I's and II's with the containment going a negative pressure. When you look at the decay heat, you know, unless you're restoring two trains of flow, 10,000 gpms, you have a significant decay heat within the containment. You are always going to be steaming off. If you start with a containment pressure of 45, 50 pounds, 250, 275 degrees Fahrenheit, you're going to be flashing, you know, all that water, all that steam.

You know, the whole issue with -- there's a long history with the potential for a negative pressure within BWR Mark I's and Mark II's. It's a consideration within design basis accidents and it's a consideration within severe accidents. There are extreme limits in what's called the drywell spray initiation limit because you want to know how many moles of non-condensable gases you have there. So it's not a new issue. And it's not associated with the filter. I mean, if you vent through the current pathways, a hardened vent and you leave it open, and you turn on sprays, if there's a concern that you're going to reintroduce oxygen, the filtered vent doesn't change that at all.

MICHAEL JOHNSON: Commissioner, could I just -- I just want to add to John's comment. I don't want you to leave with a negative impression regarding what the industry has done in terms of the EPRI effort or what actually

Maria talked about in terms of that table-topping. We think that's beneficial. The fact of the matter is we just haven't -- we don't have those details and so we're sort of speculating about what could be those details and the Commission, I believe, will get to see those and that will help us.

COMMISSIONER APOSTOLAKIS: Eric?

ERIC LEEDS: If I could make a little bit different of a point, I think Maria and Preston -- and I've watched them -- I think they believe very much in safety. I think they want to do the right thing with regard to safety. As their regulator, as their overseer, I've seen them do that. I think whatever option you pick, the staff is going to be interacting with the industry to figure out how we're going to implement it. We're going to have an ISG anyway if we go with Option 3 and I believe that the industry -- yes, we're going to have to work in a public forum with industry and whatever learnings they've gotten out of the work that they've done that they are going to share them and that they're going to be applicable and that we would incorporate them in whatever path that we go forward because everybody wants these plants to be safer. So I think they'll bring whatever learnings they have. They'll bring it to the table, whether option.

COMMISSIONER APOSTOLAKIS: Okay. The primary argument for Option 3 the way I get it from the document is the defense in depth. And Commissioner Svinicki asked about, you know, us not trusting the operators. I don't think it's an issue of trusting the operators. Mr. Lochbaum this morning said, "Yeah, they may be the greatest guys in the world, but if they don't have the right information, what are they going to do?

And again, in Regulatory Guide 1.174, it was the first time that in 1997 and '98, the staff actually said what they mean by defense in depth. It was

a little strange, but that's where they said it. And they said that we should not rely excessively on human actions. They didn't say "We don't trust them," says "We don't want to rely excessively." And I think this is really the right perspective that applies here. Thank you, Madam Chairman.

CHAIRMAN MACFARLANE: Commissioner Magwood.

COMMISSIONER MAGWOOD: Thank you, Chairman. Let me sort of echo what some others have said, and, you know, thank the staff for the analysis; it's a pretty impressive package, it's weighty, a weighty package. And I had the opportunity to meet with some of the staff -- was it last week? Or I guess it was last week, and we had a very substantive discussion which was very helpful, so I appreciate all of it, and I think the staff should also sort of recognize that that's sort of a tremendous, I guess I would say, success in bringing all parties along to basically the same understanding about what's necessary. Until the staff paper came out, there really wasn't any discussion about filtering at all, and there wasn't any discussion about severe accident capable vents. So, in essence, the large portion of the staff's work has been agreed to by everybody that's come to the table today, so I think there's success there.

So what we get to is really a more narrow issue, because I don't think there's any question that the severe accident capable vents are necessary; I think there seems to be a general agreement on that. So I think there's a narrow issue of how do you do the filtering, and that's the substance of the discussion that we've had on this panel. And I guess, to some degree, in asking that question, I reflect back to what our Canadian colleague said when I asked about their approach, and they emphasized that they need that this is something that needs to be looked at on a plant-by-plant basis. Every plant's different,

every plant's a different design, every plant has different circumstances. And that's really, since I've been here, almost three years I've been here, that's been sort of the staff's most important lesson, I think, for me, as someone coming into this business, you know, almost three years ago, which is that every -- they're all -- all the children are different, they all have their own idiosyncrasies, they all have their different behaviors, they all their different configurations, and that the hard work of regulating is to recognize those differences and to deal with them as we go.

So to some degree, I ask the question, and I'll ask you, John, I mean, when you look at this issue, we narrow it down to really the essence of what I think I hear, where I see the discussions taking place, it really is a discussion about, shouldn't we really look at this on a plant-by-plant basis? And for some plants the answer's going to be, you know, wet filters; for other plants, it might a combination of dry filters and other strategies such as TVA is talking about; and there might be some plant that convinces the staff that we don't really need a filter, we have another way of doing this. But I think that the -- sort of the downside of Option 3 -- there are certainly upsides of Option 3, but the downside of Option 3 is you never have that conversation. You never have that conversation about what if we do it this way. And the ACRS, as a matter of fact, sort of quickly flip back to the ACRS commentary. The ACRS said, "We prefer Option 4," and the reason they give, "It allows more scope for innovation and may result in more effective solutions." Now there's -- but they also -- there's also a backstop. They also recognize that Option 4 could ultimately lead you to basically the same as Option 3, so there's -- so it's not that Option 3 -- it's not that vents are -- that filters are bad, or that there's something inherently wrong with

them, it's simply, why not do the homework, why not do the analysis, why not go plant by plant and analyze the situation, decide whether particular plants should have, you know, either wet filters, dry filters, combination of filters, just, -- let me let you sort of react to that.

JOHN MONNINGER: Yeah. So some of the thought is, you know, is it prescriptive of the filter or does it provide some level of clean-up within the -- within the atmosphere. The notion of doing a complete assessment when we interacted with several countries around the world, they started with the notion of what can potentially be done with these plants, and, ultimately, it appears that they all ended up with a position of engineered filters.

So you can do that work, and we believe a lot of that work is what is within the EPRI report, and they looked at various strategies. One strategy spraying outside the torus, and they said that's not significantly sufficient. But when it comes down to it, the two innovative things that are currently on the table -- everything else within the report is past practice, common knowledge, SAMGs, et cetera. The two innovative things are the cycling of the valves and drywell sprays. So, you know, and that's been looked at for the past year, and that is the result of that.

So then the question is, you know, if we go forward, you know, another year or two, and there are very smart people, utility by utility, maybe they will come up with something in addition to the sprays or in addition to the vent cycling. But there has been a lot of people that have looked for solutions to the problem.

COMMISSIONER MAGWOOD: To some -- you know, to some degree, I guess, the way I look at this question is, I've thought about, it seems to

me that what EPRI has presented, and I've looked at the EPRI report, and, you know, I have lots of questions about the EPRI report, we could probably spend days talking about the EPRI report, but, to me, it's more of a toolbox than anything else, and it's a toolbox that they've put together that could be used by licensees to put together whatever story they have. And some licensees are going to say, "No, that's okay, let's just put in the vent," and some licensees will be more like Preston, and it'll be some combination of effects. I mean, it's more complicated, and it might take a little longer. And I'm -- I sort of agree with what David Lochbaum said; I'm more interested in getting the right answer than, you know, getting necessarily the fast answer, although I'm not sympathetic to having this drag on for eons. So I just -- I'll just make that more of a commentary than a question, so -- unless Mike, it looks like he wanted to jump in there.

MICHAEL JOHNSON: Yeah, Commissioner. You know this, but I just wanted to say it anyway -- and at the end of the day, we would have to make a decision about whatever would be acceptable based on, for example, if the Commission when with Option 4; we would still ultimately end up needing to make a regulatory decision to accept whatever that -- from the toolbox -- that list of strategies look like and whether or not it was acceptable for it to meet our requirements, so that's --

COMMISSIONER MAGWOOD: No, I appreciate that. You know, it's -- it was interesting. As Commissioner Svinicki was describing the process that we normally go through and looking at things on a risk-informed basis, you know, it actually sounded a lot like the analysis that we've doing for seismic and flooding. You know, we're going out, basically plant by plant. We're looking at the specific -- we're doing walkdowns, we're doing very specific work at each

plant to make sure that those plants are prepared for the flooding events that are appropriate in their areas. We could've very easily just told all the plants, "Put up 15-meter walls around your plants, and we're done." It's easy, you know, it's much simpler, it's much higher confidence, and the operators don't have to worry about manual actions. We'll -- you know, we could've done that. But we didn't do that, and -- because, in that case, it sounds a little silly, to think about just putting 15-meter walls around all our plants. But, you know, in some sense, it's pretty close to the idea of just simply saying, "Let's all do -- let's all do filters." But, you know, obviously, the staff doesn't feel that that way about it. [laughs]

Well, let me ask a question. This issue about the core debris cooling was -- it sounds like there seems to be some discussion that needs to take place on that point. But let me ask you a very specific question about that. Under 50.54 (h)(h), utilities have purchased and are training to particular pieces of equipment. We've all seen the big pumps that they all have, we've all seen the fire trucks. You know, for example, I've been out to a plant recently and they showed me their big, shiny, new fire truck which they use as their B.5.b pump. Can those trucks pump into a severe accident damaged core? Do they have the ability to pump water into a vessel that has core melt?

JOHN MONNINGER: So there's the containment vessel and then there's the reactor vessel.

COMMISSIONER MAGWOOD: Yeah.

JOHN MONNINGER: So containment vessel -- I'm sorry, the reactor vessel will be more difficult, and it would depend upon the particular accident sequence, whether you're at a high pressure, whether you're at a low pressure, and, eventually, they all are supposed to depressurize. However, there

are some sequences that will unfortunately remain in a high RCS pressure. With regard to the containment the max back pressure would be, you know, 45, 60 -- you know, 45, 60 pounds or so when the fire trucks should be able to handle that.

COMMISSIONER MAGWOOD: So -- and so when you think about this, you're thinking about flooding the containment, but not in-vessel?

JOHN MONNINGER: I think within the NEI document, and Eric is here, there's requirements for both, when we talked about it, we were just invoking the provision for flooding to the reactor cavity, but Eric is our B.5.b. guy.

ERIC BOWMAN: Good morning, I'm Eric Bowman. The document that contains these strategies is the NEI 06-12, which was the phase two and three requirements for B.5.b., which became 50.54 (h)(h)(ii). For both PWRs and BWRs, there's a strategy in there for connecting a portable pump to provide 300 gallons-per-minute flow to flood containments. All of the licensees of the current operating reactor fleet provided us with their strategies. We reviewed them, we went out, and we did site-specific verifications that they're capable of doing it. And what we looked at was the engineering basis to show that they could deliver a flow of that magnitude against the containment design pressure. For the BWRs, there's also a requirement for depressurizing the reactor pressure vessel and injecting to the reactor pressure vessel, I believe it was at 200 gallons per minute.

COMMISSIONER MAGWOOD: Okay. And that would be sufficient to maintain the liner in the event of a core melt?

ERIC BOWMAN: I'd have to defer to the containment guys, but my understanding is yes, it would.

COMMISSIONER MAGWOOD: Okay. Just to suggest it sounds like there needs to be a conversation with the industry to make sure of --

MICHAEL JOHNSON: We can take that away as a question.

JOHN MONNINGER: Maybe one point of interest -- some of the staff's conclusions talk about the need for both, and what ultimately -- there is still a residual risk associated with containment failure. We believe the numbers have potentially -- with Option 3 a passive system move from a 0.8, 0.9 to maybe a 0.3, 0.35. That 0.35 is not dominated by the filter; the 0.35 is dominated by the operator actions for the B.5.b. measures. We recognize you need both. The containment -- so there is still the potential that that system does not work, and the staff's analysis assumes a failure of 0.3 based on past analysis that has occurred. So we're looking at both of them, it doesn't drive it to zero, but we do believe it significantly decreases it, and it's still elevated due to the cavity flooding system.

COMMISSIONER MAGWOOD: Okay. All right. I know you guys will look into this further. Okay. Thank you. Thank you, Chairman.

CHAIRMAN MACFARLANE: Okay. Additional questions? No?

COMMISSIONER APOSTOLAKIS: Yes, I do just to clarify something. I was looking at the draft order that you have given us, and it says, "All licensees shall within 20 days of the date of this order to notify the Commission if compliance with any of the requirements is unnecessary in their specific circumstances." Could Ms. Korsnick use this and come to you and say, "Well, here. I have a strategy; I don't need to do what you're telling me." Is that the intent of this, or is something else?

ERIC LEEDS: Yes, she could. That's boilerplate, and that's typically what we put out to the licensee, because we don't want to tell them to do something that would be adverse to safety, so if they know something that we don't, that's their opportunity to say, "No, we've got a better idea, NRC," or, "What you're asking us to do may not be in the best interest of safety."

COMMISSIONER APOSTOLAKIS: So, parts of four are already in three?

ERIC LEEDS: No, sir.

COMMISSIONER APOSTOLAKIS: Thank you.

CHAIRMAN MACFARLANE: Can I ask just one more question? One more quick, quick, point of clarification, and I -- this occurred to me with Commissioner Magwood's question, pointing out that each BWR Mark I and Mark II is different from the other. Is it possible that one outcome of Option 4 is to do nothing more than what is being done now?

JOHN MONNINGER: If -- well, if the question is what is being done now, but if, you know, the success criteria is potentially a decontamination factor of 1,000, that actual decontamination factor of 1,000 is different from what is universally talked about for a decontamination factor of 1,000 for a containment atmosphere. You know, the first one relies on all the in-vessel effects, the plate out within pipes, et cetera. So, depending on what the acceptance criteria was, you know, they may come in and a plant could potentially show that they don't even need vent cycling, or they don't -- well, they would somehow need to vent, but maybe they do not need drywell sprays, I mean, that is a potential, it would all be based on the plant specifics and whatever that acceptable value was based on.

CHAIRMAN MACFARLANE: Okay. Okay. No further comments? Questions? No?

Okay. Great. Well, then, we will draw this meeting to a close. I want to thank, again, the morning's panel, and -- well, morning's panel. This is all the morning, isn't it? The earlier morning panel, and you guys, as well. I think it was a very fruitful discussion today, and now we have a lot to go forth and chew on, so I really appreciate it all. Thank you.

[whereupon, the proceedings were concluded]