UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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BRIEFING ON SPENT FUEL POOL SAFETY AND CONSIDERATION OF EXPEDITED TRANSFER ON SPENT FUEL TO DRY CASKS

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The Commission briefing convened in the Commission Hearing Room, One White Flint North, 11555 Rockville Pike, Rockville, Maryland, at 9:00 a.m., Allison Macfarlane, Chairman, presiding.

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

9:00 a.m.

CHAIRMAN MACFARLANE: Good morning. So the Commission meets today to discuss the NRC staff review and recommendations regarding expedited transfer of spent nuclear fuel from pools into dry storage casks at reactors.

Over the last few decades the NRC has examined the risk of potential spent fuel pool fires from severe accidents. This issue is important because the spent fuel pools contain a significant cesium source term and don't have the benefit of containment structures. Although spent fuel becomes significantly cooler after the first few months of discharge into the pool, there's still a period of time when it may be vulnerable to potential self-ignition, generation of hydrogen and significant release of cesium if the cooling water were lost from the pool.

Now the physics of self-ignition during a drain-down event is very complicated and the arrangement of the hottest fuel in the pools in the racks is one factor in this event, potential event. Now after 9/11 in particular many organizations and the public have raised concerns about the vulnerability of spent fuel pools to fires and terrorist attacks, and now after Fukushima concerns have been rekindled again.

The staff has recently completed a consequence study based on the spent fuel pool at the Peach Bottom reactor, and in addition a more recent regulatory analysis that analyzes the need for expedited transfer of all spent fuel from U.S. pools into dry casks. Not all fuel, but of a certain age.

The staff has delivered a paper to the Commission that recommends that expedited transfer is not warranted and that the NRC needs not pursue any further generic assessments in this area.

So the Commission today is interested in hearing from the staff on the findings of their consequence study and expedited transfer analysis for all spent fuel pools. In addition, we're also interested in hearing from external groups, and we're going to hear today from both industry and non-governmental organizations as well.

So let me first say that -- I'm going to ask each of you panelists to keep your remarks to, I believe, 10 minutes. We have a great deal to talk about today, so please pay attention to the timing lights in front of you. And I ask you also to try to avoid using acronyms to the extent possible. We'll allow NRC --

(Laughter.)

CHAIRMAN MACFARLANE: -- but the public is, you know, watching this and we want to make this as accessible as possible.

So what we'll do is we'll have our first panel and then we'll have a short break and then we'll hear from the staff. Okay.

Let me first ask my fellow Commissioners if anybody has any comments they'd like to make.

(No audible response.)

CHAIRMAN MACFARLANE: No? All right. Then with that, I'm going to turn to the first panelist. We have Mr. David Heacock, who is president and chief nuclear officer of Dominion Nuclear.

MR. HEACOCK: Thank you, Chairman Macfarlane. Appreciate it. And Commissioners, Happy New Year. Appreciate the opportunity to express the position of the industry here this morning.

Next slide, please. The NRC staff has performed a very thorough conservative analysis to determine whether it makes sense to remove the older or used fuel from the spent fuel pools or not. Since the older fuel represents a small fraction of the heat load and a small fraction of the gaseous off-site dose consequence activity, it just makes perfect sense that the conclusion would be it makes no sense to remove this fuel from the pools at this time.

Next slide, please. In case of all these 21 spent fuel pools that were studied by the Nuclear Regulatory Commission staff, they all experienced seismic events that were greater than their design basis earthquakes. In the case of North Anna, I worked at that plant for 25 years, very familiar with the design of the plant and the spent fuel pool. And it just so happens I've been to all these facilities that have all 21 of these spent fuel pools in the last few months. I visited Kashiwazaki-Kariwa, Fukushima Daiichi and Daini in September. That was my second time back to Daiichi and Daini.

And you can see from Daini specifically that that had essentially the same earthquake that Daiichi had. Daiichi had the hydrogen explosion. It's more difficult to determine what caused what, whether it was a hydrogen explosion, seismic event, tsunami, etcetera. Daini's a little clearer. When you go look at that you can kind of discern what was tsunami, what was seismic event. No hydrogen explosions obviously. So you see almost no seismic damage at Daini. Onagana was actually closer to the epicenter and the pools there survived with no issue whatsoever. There was some sloshing. Minor amounts of water lost. So this is all very consistent with what we saw in the study that was done. No significant damage.

At North Anna the same thing was true, the August 23rd, 2011 earthquake. There was no safety-related structural damage. There was some cosmetic concrete spalling and some ceiling tiles falling, those kind of things. But we had an earthquake that was about twice the peak ground acceleration of the design basis earthquake at North Anna right here in Virginia August 23rd of 2011. And the spent fuel pool did not slosh, did not lose any water, did not lose cooling. There was really no consequence at all in that event.

Next slide, please. I thought I'd include this for a little bit of context, some photographs here of Kewaunee, North Anna spent fuel pools, as well as the dry cask storage facility for used fuel at Kewaunee. The point I want to make here is you can see particularly in the Kewaunee picture really how small a pool this is. This is a single-unit site, but the fuel assemblies are essentially the same dimension as a full-sized reactor. So the left and right and horizontal dimensions are the same, but it's only for one unit.

You can also see the individual standing on the wall there to get an idea of how robust these facilities are. It's about three-foot thick concrete, steel-reinforced structure that supports the spent fuel pool lined with a stainless steel liner. And the NRC spent a lot of attention on what happens to the concrete and what happens to the liner. And this is just kind of a way of putting it into perspective for you.

The pools are about 40 feet deep. The other thing to note here is that for Kewaunee we're in the process of going from an operating unit to a shutdown unit and placing the unit in safe store. As a result of that, we've done some of the same calculations that the NRC did in their consequence analysis for our Kewaunee plant and got essentially the same results. So our calculations agree very closely. We saw the same conservatisms that the NRC saw that I'll discuss in just a minute here.

Next slide, please. The Fukushima Daiichi Unit 4 is an example of how robust these spent fuel pools are. This was the fourth largest earthquake ever recorded in history. The building was damaged extensively by a hydrogen explosion as well. And as I pointed out, it's hard to say what's what. You can see it at Daini. You can't see it at Daiichi because they were so close in proximity time-wise to one another. But the pool structure, operating deck and all are essentially still intact, and the pool lost very little inventory. Although there was a lot of concern over it, it did not really lose inventory.

Next slide, please. The analysis that was done for Peach Bottom assumed an earthquake about six times their safe shutdown earthquake magnitude. Very, very large size earthquake. So there's a conservatism to begin with that the earthquake chosen was very large. Even with that large earthquake that was chosen, which was larger than Fukushima Daiichi experienced, for example, the fourth largest earthquake in history -- so this would have been the third largest earthquake in history that was analyzed in this particular analysis here. Even with that, there's a small probability of pool leakage.

In order to get that, the staff assumed the fragility or the ability for the liner to tear much more so that it actually was. They used carbon steel instead of austenitic stainless steel. Austenitic stainless steel is much more resistant to tearing than carbon steel. And they used some other conservatisms in that analysis. So they ended up with assuming a small probability of leakage and calculated that in the consequences here.

Next slide, please. You know, we saw earlier at least 21 spent fuel pools have seen a seismic event more severe than their design basis earthquake today with really no significant consequences. And as the Chairman pointed out, there's been numerous studies over the last several decades and they all really have the same conclusion, that the spent fuel pools are really not a significant source of off-site dose or consequence.

For example, in the high-density case and low-density case, if you want to look at those two cases, for the high-density case there's a four-and-a-half orders of magnitude of margin between what was calculated and the safety goals set by the NRC. On the low-density case it was five orders of magnitude. So there's a half an order of magnitude difference between these two cases, both of which are well conservative, much more safe than the safety requirements require, approximately 100,000 times safer than the goal.

Next slide, please. Today all the plants in the United States have procedures to deal with loss of spent fuel pool inventory. We've always had procedures to do that. As a result of the September 11th, 2001 attacks in the United States, the security-related orders required additional safety measures to be taken. We've put in place additional equipment and procedures to deal with that. And the study takes credit for those. What the study does not take credit for is now we have the flexible diverse equipment required as a result of the Fukushima accident at all of our facilities. We also have procedures in place to deal with this. And the equipment is still coming on site.

For example, at Dominion sites we have equipment at all the sites today to deal with that issue. We're also going to have regional support centers. The Memphis center is already established. The Phoenix center will be established by the first half of this year. In addition to that, there are 62 other sites available to borrow equipment from to provide water. The bottom line is that this is not a complicated mitigation, nor is it difficult. It's simply just add water. That's what the consequences is. That's what the compensatory mitigation is.

Next slide, please. The NRC staff, and correctly so, used multiple layers of conservatism in their analysis. Each layer was designed to favor expedited fuel off load. Even with all those conservatisms added and the favorability added to it, it didn't really result in any change here. Very conservative analyses were used, as I mentioned earlier, for spent fuel pool liner fragility or how easily the liner would tear. A very large earthquake was used. In the high-density case mitigation was assumed. In other words, you could go in and add water easily or spray the pool down. In the low-density case mitigation was assumed to not be successful. That assumption alone adds a factor of 19 to the case difference. That's a big difference there.

Next slide, please. I mentioned over the decades there have been numerous studies that have analyzed the spent fuel pools' existing high-density configurations and all determine that they would be extremely safe with considerable margin to the requirements, to the safety goals. We have seen a number of cases where the seismic event has exceeded the capacity designed into the spent fuel pools and we found from the North Anna earthquake there's tremendous conservatisms even in the codes used.

I'll give you a quick example: One of the non-safety buildings that houses our station blackout diesel at North Anna, we put that earthquake into the design basis code for the building and it said the building would collapse, because the conservatism is in the design code. Now the building did not collapse. Actually it had zero damage to it. So the design codes have significant margins built directly into them. And this isn't an accident analysis code. This is design code. They're not intended to analyze accidents that occur or events that occur.

It's easy to get off track and focus on the consequences of these events without looking at the probabilities, and the probabilities are very, very important in this case. We're seeing numbers like 1 in 10 billion per year, 1 in a trillion per year. These kind of numbers, engineers have a hard time saying this, but they're effectively zero. When you get that many zeroes in front of a decimal point, it's effectively zero. One in a trillion is a very, very small number.

Madam Chairman, that concludes my remarks. Thirty second to spare.

(Laughter.)

CHAIRMAN MACFARLANE: Thank you. I like it. Keeping us on time here. That's great.

All right. Next up we have Christine King, who's director of the Nuclear and Fuel Chemistry Activities at the Electric Power Research Institute.

MS. KING: Thank you very much. Good morning. Thank you for the opportunity to speak to you today not only about the expedited transfer, but what we're doing at EPRI in terms of research around spent fuel management.

Next slide, please. A necessary and important task associated with the operation of the nuclear power plant is the management of spent fuel. It has become necessary to transfer spent fuel from the pools to dry storage. At this time fuel is transferred from the pool to dry storage at a pace to keep up with -- to support refueling operations for the reactors. Accelerating this pace requires a multi-faceted evaluation and has been evaluated by multiple organizations.

There are numerous factors to be evaluated and balanced as a decision is reached whether expedited transfer from the pool to dry storage improves the safe storage of nuclear spent fuel. Not only has EPRI evaluated the expedited transfer in spent fuel, but today I'd also like to talk to you about what we're doing in our current and future research programs.

Next slide, please. The EPRI study models representative plants as well as looking at an industry-wide impact of acceleration. It's difficult to determine what factors should dominate a decision associated with acceleration. Assuming a particular spent fuel inventory for the fleet, we did evaluate how accelerated transfer would impact operations, drive the potential need for design changes in the casks and/or the ISFSIs; I'm sorry, independent spent fuel storage installations, and the spent fuel pool inventory in the pool and how that changes the decay heat and the cesium-137 inventory in the pool.

However, our study does not address how to maintain off-site dose at its current limits if you're going to load shorter cooled fuel. We did not address additional inventory from new plants even though we realized that's a likely reality here in the United States and we did not attempt to quantify the risk associated with the increased fuel handling activities.

So what we looked at is a base case, and the base case is basically the pace at which we're transferring spent fuel from the pool today to dry storage. And then we looked at a 10-year case starting in 2015 and a 15-year case starting in 2015 as well. We did not attempt to optimize the timing here. We didn't look to see how fast could it be done. We just evaluated a couple scenarios to see what the impacts would be.

Along with some of the other assumptions made we did have to assume what the spent fuel discharges would be. How high would the burnup be? We did look at the dry storage requirements and the technology and whether using existing technology you short load, and the timing of each case, whether we could license new canister designs and work with the higher heat load fuel that would be expected.

We looked at the available time, whether it was a single-unit site or a multiple unit site. What is the available time to actually load new casks and the associated worker dose with that. And we looked at the cost for construction of additional casks and the increased shielding inside the cask. We did not look at any modifications to the actual pad or changes to the site boundaries because of increased dose out on the dry storage.

Next slide, please. So our study indicates that you can get a large reduction in the inventory in the spent fuel pool, up to 75 percent. This is coupled with a reduction in the cesium-137 source term, up to 53 percent. However, accelerating the transfer only provides for at most a 32-percent reduction in the decay heat for the pool. To achieve these results it does require loading additional canisters, upwards of 100 canisters above what we're doing today. It did involve increased worker dose. And as I mentioned before, a potential change in the public dose.

EPRI has completed other studies associated with this issue. For example, we recently have published a risk framework for the spent fuel pool and piloted that on a BWR plant. We've evaluated the Fukushima Unit 4 spent fuel pool following the tsunami and earthquake, and we continue to follow the NRC's research on spent fuel pool fires.

The cost associated with doing expedited transfer by our estimates is an additional $3½ billion to the industry. If you were to break that down to one particular plant, you're looking on the order of 20 to $30 million to effect the expedited transfer.

Next slide, please. Given the DOE's current strategy for storage of used nuclear fuel, extended storage of spent fuel at plant sites will be necessary until the plants are decommissioned. Our experience with aging management of the operating plant leads us to proactively plan for aging degradation of the dry storage systems to ensure that we fill any technology or knowledge gaps prior to any indication of degradation.

EPRI's program is focused on understanding the fundamental behavior of fuel cladding as it cools, the management of the dry storage systems themselves, and ensuring that we develop the data necessary to support transportation after long-term storage. We've worked with our Extended Storage Collaboration Program, which is an open program with regulators, international regulators, research organizations from across the globe to develop a research gap list and prioritize that. As such, one of the highest priority gaps we had was associated with high burnup fuel cladding properties and we recently initiated a full-scale demonstration project with the DOE to study how the high burnup fuel cladding responds to long-term storage, which eventually Dave here is going to nicely host at North Anna.

We expect the project to take about 10 years to complete, but it should provide the industry the necessary confirmatory data to support storage and transportation of high burnup fuel.

Next slide, please. As I mentioned earlier, there are numerous factors that need to be evaluated and balanced relative to a decision on expedited fuel transfer from the pool to dry storage and whether this improves to the safe storage of nuclear spent fuel. EPRI's research will be focused on proactively evaluating the need for aging management of the dry storage systems themselves and preparing for the day when we need to fully load casks with high-burnup fuel, since that's what we're discharging from our plants today.

And I'd just like to go on record to say I beat you. You have two-and-a-half minutes back.

(Laughter.)

CHAIRMAN MACFARLANE: All right. Even better. Thank you very much. That was very informative.

All right. We are now going to hear from Dr. Gordon Thompson, who is a research professor at Clark University and the executive director of the Institute for Resource and Security Studies up in Cambridge.

DR. THOMPSON: Thank you. Good morning. Can I have the slide? Thank you.

My presentation is supported by three declarations that I've asked to be distributed to the Commissioners that were produced on behalf of a consortium of environmental groups around the United States, but this presentation is strictly my own views.

Next slide, please. This slides slows a low-density rack. The NRC staff appears to have forgotten what a low-density rack looks like. These used to be standard. In my view it's a reasonably respectable piece of nuclear engineering passively safe against water loss under most circumstances.

Next slide, please. I don't expect you to read all the detail of this slide on the screen, but the point is that the staff has looked at only a small fraction of the possible scenarios that could lead to loss of water in the event of an accident or an attack. And I'll return to probabilities of these events later. So there's a large number of scenarios that are just not addressed at all in staff analysis to date.

Next slide, please. This slide shows a situation of partial loss of water from a spent fuel pool which I describe as the severe reference case. This represents many possible scenarios for loss of water and for three decades plus the NRC has refused to systematically study this case even though there has been a partial precedent in the Paks-2 accident in Hungary in 2003.

Next slide, please. This slide shows what I describe as ignition delay time, which is the shortest time required for spent fuel to heat up to the point of zircaloy ignition. This shows that we're dealing with a relatively slow developing incident for fuel aged 1,000 days, a little over three years. We're looking at 21 hours in the fastest case for heat up. So you might think if the incident is so slow developing, why should we worry about it?

Next slide, please. This gives a hint as to why we might worry about it a great deal. This illustrative case shows the on-site contamination due to a reactor release. It's a simplified illustrative case, but in this instance average over the first day a lethal dose would be accrued in 4 minutes of exposure and over the first 7 days within 10 minute of exposure suggesting that in this incident or others like it mitigating actions would be precluded if they involved any human action on site.

Next slide, please. Outcomes. Why are we worried? We've had two large actual releases. In the Chernobyl case Mikhail Gorbachev retrospectively concluded that this release was perhaps the dominant cause of the collapse of the Soviet Union, and one could extend that to the Warsaw Pact. So dramatic political and social effects. In Fukushima where we have a fallout of only 6 petabacquerels there are to this day 160,000 people reportedly displaced and the entire nuclear fleet is shut down.

Looking at potential releases, the NRC has looked at the Peach Bottom release of 330 petabecquerels leading to long-term displacement of 4.1 million people, which I would submit would be a national disaster. The French agency IRSN has attempted to add up all the economic damage from a hypothetical release of 100 petabecquerels at the Dampierre facility and their high case is $8 trillion, which is about half the current U.S. gross domestic product.

Next slide, please. Inventory is available for release. Each pool at Peach Bottom, 2,200 petabecquerels, twice what's in the Fukushima Unit 4 pool and a great deal more than the 6 petabecquerels fallout in Japan. And circumstances at Peach Bottom could lead to a release in the range of 2,000 petabecquerels, vastly greater than what we experienced at Chernobyl or Fukushima.

Next slide, please. Brings us to some broad questions about risk. It's common to say that risk is the product of probability and consequences. Although that's common, it's important to be clear that this is not a scientific statement. It's a statement of ideology. It's a statement of value and has no scientific basis.

What should be the indicator of probability? Given the scale of consequences of a very large release of cesium, I believe an appropriate indicator would be the number of occurrences per century across all nuclear facilities in the United States. The probability and consequences could be determined in large or dominant part by qualitative factors, and that's particularly true of potential attacks. And having a large amount of cesium positioned where it can be released by attack I submit actually attracts attack and increases the probability. It's I think legitimate to describe spent fuel pools adjacent to operating reactors as pre-in-place radiological weapons awaiting activation by an enemy of the United States.

Final observation is that the staff has for more than three decades focused on rapid and total loss of water from spent fuel pools. This is a reprise of the focus in the 1960s on large break loss of coolant accidents from reactors and this in my view fundamentally warped the design of reactors in terms of containments and safety systems.

Next slide, please. The Fukushima incident some people take as a sign of reassurance. I take it as a wake-up call.

Next slide, please. Now reverting to low-density open-frame racks; and I'm talking about true low-density open-frame racks, not the low-density case considered by the NRC staff, the cost driver is predominantly the transfer cost to transfer fuel from high-density racks to dry casks. Now this transfer is going to occur anyway when the reactors are shut down in the absence of a repository or a centralized store, thus the incremental cost of acting now is simply the time value of the transfer cost. The preceding speaker from EPRI quoted around $3½ billion. I'd submit that the true cost is substantially less than that. It's whatever the time value is of that cost. There is an issue of high-burnup fuel which complicates the transfer to dry casks. That symptomatic of a larger problem with high-burnup fuel that I believe requires attention.

Final slide, please. Conclusions. Given the information available I believe that the Commissioners should order the rapid reversion of all pools in the United States to low-density open-frame racks. That would require excess spent fuel to be transferred to dry storage.

The Commissioners should also require the staff to scrap its pool-fire consequence study and its Tier 3 analysis and send them back to do a really thorough open and science-based inquiry into the phenomena related to pool fires including risk linkages between pools and reactors. And in the declarations that I've submitted and that I mentioned earlier I have laid out in some detail what those investigations should cover. And at the same time the issue of cask fires should be addressed. And I can explain what I mean by that, if necessary.

And this inquiry should be internationalized because pool hazards exist elsewhere. Le Hague in France is a good example where there are four pools positioned so that the mid height of the fuel is about at grade level and they're licensed to hold almost 18,000 tons of spent fuel. That's I think the largest spent fuel hazard I'm aware of, hence an international inquiry would be appropriate. Thank you.

CHAIRMAN MACFARLANE: Thank you, Gordon.

All right. We're still on time here. Okay. Ed, pressure is on you.

DR. LYMAN: Don't count on it.

CHAIRMAN MACFARLANE: I know. All right. Next we're going to hear from Dr. Ed Lyman, who is the senior staff scientist with the Union of Concerned Scientists.

DR. LYMAN: Thank you and good morning. On behalf of the Union of Concerned Scientists, we appreciate the opportunity to present our view on this very important issue.

UCS has long supported expedited transfer of spent fuel to dry casks as a prudent passive defense-in-depth measure that can significantly reduce the risk from accidents and attacks on spent fuel pools. We have reviewed the staff's documentation with an open mind and detail and our conclusion is we don't believe it has provided adequate support for its recommendation that this issue be closed out at this time.

We personally do not think that more study is needed to make a decision to proceed with expedited transfer. But putting that aside, we believe that at a minimum Phase 2 should proceed because there are many unexplored issues that deserve fuller analysis. This is a substantial safety improvement and any regulatory scheme that does not indicate that is a defective scheme.

Next slide, please. The NRC's responsibility is to protect the health and safety of everyone, not just an average citizen affected by an average accident. So even if the calculations based on averages in most cases suggest action is not warranted, there are still dangers posed by high-risk outliers, and those need to be addressed in order to fulfill NRC's mandate.

Next slide, please. The staff has provided significant non-concurrences to the regulatory analysis in COMSECY-13-0030 and they raise serious issues with the study's methodology, and we believe the Commission needs to give these objections great weight. We don't think the management response to the non-concurrences adequately address the concerns raised by the staff.

Next slide, please. To reiterate what Gordon has just provided, I'd just like to show three numbers. These are a little bit different from what Gordon provided, but the total cesium release from the Fukushima Daiichi accident was in the vicinity of half a megacurie. According to the staff's Spent Fuel Pool Study, the maximum release from a low-density pool scenario was less than that, around a third of a megacurie. And the peak release evaluated in the study, which was far from the peak release possible for the high-density 1x4 scenario was 24.2 megacuries. So simply by going to low-density fuel storage you can almost guarantee that you're capping the consequences of this event of a spent fuel pool fire at something less than what happened at Fukushima, which I would argue is pretty bad already.

Next slide, please. Three more numbers again to provide perspective is that the U.N. has estimated about 32,000 person-Sievert for the collective dose to Japan from Fukushima Daiichi. Again the Spent Fuel Pool Study found for a low-density pool with no mitigation the peak collective dose was less than that, around 27,000, and for the high-density 1x4 it was more than 10 times more, 350,000 person-Sievert.

Next slide, please. Now we think that dry casks in transition to low-density pool storage are essentially fulfilling the NRC's desire to see more passive safety technologies in the future. If someone came to you and said they had a new spent fuel storage technology that would greatly reduce the potential cesium release from a spent fuel pool fire using highly reliable and less complex shutdown decay heat removal systems using inherent or passive means using simplified safety systems that reduce required operator actions and designs that minimize the potential for severe accidents and their consequences, you would probably think that was a pretty good new design. Well, that's exactly what a transition to dry casks and low-density fuel storage could achieve based on the staff's own analyses. And I just remind you, this came from the NRC's Advanced Reactor Policy Statement, these principles.

Next slide, please. We think the staff used the wrong methodology in trying to evaluate the value of expedited spent fuel transfer. The quantitative health objectives are not the right metrics to evaluate land contamination events because they focus only on acute exposures to areas very close to the plant. And if your analysis assumes essentially substantial or complete evacuation of that area to begin with, then the quantitative health objectives almost by design will not show significant consequences. So they simply are not the right metric to use.

The cost benefit analysis that the staff has used and is based on the current regulatory analysis guidelines does not give adequate weight to features that are important in a spent fuel pool fire such as the impacts beyond 50 files, such as increased reliance on defense-in-depth to compensate for uncertainties, non or less easily quantifiable aspects of land contamination and security considerations.

Next slide, please. There are many flaws in the regulatory analysis in the Spent Fuel Pool Study that we've identified, but I'll just point out a few of them. The regulatory base line in the study assumes that spent fuel is immediately off-loaded into a 1x4 configuration and that the pool has full core off-load capability. Both of these assumptions provide a substantial additional benefit in the event of a spent fuel pool loss of water which may not be reflective of the actual state of the fleet. More on that later.

The regulatory analysis is a patchwork of different studies. There was no comprehensive evaluation of pressurized water reactors pools as there was in the Spent Fuel Pool Study, and so two-thirds of the fleet has not been considered on a consistent basis with boiling water reactors. These numbers were pulled out of older studies and it makes it very hard for the public to understand if the different numbers are done on a consistent basis.

Also, the studies assume evacuations of up to 30 miles and sheltering actions ordered between 30 and 40 miles for high-density scenarios and only 10 miles for the low-density low-release scenarios. This is well beyond the EPZ regulatory requirement. I would argue that sways the analysis in a non-conservative fashion toward high-density pools. I would like to see the analysis with that assumption relaxed.

Next slide, please. I don't think I have time to go through these, but a 72-hour analysis limit is unrealistic in light of the situation that we saw at Fukushima where there was argument for many more days than that over whether it was ever necessary or appropriate to add water to that pool. So I would disagree with Mr. Heacock's position that that was a no-brainer event. It was a lot more complex than he's giving credit for.

Many of these issues were examined in a very limited way in sensitivity analyses in the regulatory analysis, but it does not specify how you deal with different results when the cost benefit analysis shows that there's a positive benefit. In certain sensitivity analyses the staff just brushes that aside. The study has not adequately accounted for uncertainties. In the state-of-the-art reactor consequences analysis the independent peer review panel and the Advisory Committee on Reactor Safeguards both said you need an uncertainty analysis. And I think I have that document here. It's a thick document analyzing the uncertainties and the kind of consequence analysis that the staff has done without that analysis for the Spent Fuel Pool Study. There needs to be a comprehensive uncertainty analysis to make sure that you are adequately addressing the full range of events.

Next slide, please. Mitigation. One word on mitigation is that the study claims that 50.54(hh)(2) measures; that is otherwise known as B.5.b, were assumed. But if you actually look at what the study did, it assumed that there was a miraculous expansion in the capabilities of those B.5.b measures. So what the study actually assumes is something closer to the fully-implemented FLEX Program than B.5.b.

Also, the assumption that successful mitigation only applies for low-density pools; I've looked at the calculations, it appears it would affect the answer by 10 percent or less, which would not make a very big difference. And the reason for that is that the consequences of low-density accidents are so much lower already that that additional factor of 20 would not make a big difference in the outcome.

Next slide, please. I'm running out of time. Security is also a consideration for defense-in-depth. I'm afraid I don't have time for these.

Next slide, please. But the NRC cannot affirm that 1x4 configurations are actually achieved or how long it takes for them to be achieved after refueling. So again, the baseline of the study does not reflect what the public can understand the state of the fleet is.

Next slide, please. I'll skip that.

Next slide, please. One other aspect, hydrogen mitigation. It should be clear from these analyses that only high-density scenarios produce sufficient hydrogen for an explosion, that avoidance of hydrogen explosions has many benefits in addition to mitigating consequences, but also for reducing occupational hazards for multi-unit accident risk, site cleanup and decommissioning.

Next slide, please. So finally we think that a new framework needs to be implemented to fully understand the benefits of expedited spent fuel pool storage and that any decision should be deferred until that new framework is in place. Thank you for your time and I apologize for going over.

CHAIRMAN MACFARLANE: Great. Now we can move onto questions. Thank you all very much for your presentations and I think we look forward to a robust Q & A session right now. We'll start off with Commissioner Svinicki.

COMMISSIONER SVINICKI: Thank you. Welcome to all of you and thank you for each of your presentations this morning.

As someone who yesterday was reviewing some transcripts of previous Commission meetings on related topics, I'm going to begin with a correction that I think is needed, and I apologize if I didn't hear this right, but Mr. Heacock, I think on your slide 9 when you talked about the cases where mitigation was assumed effective and not effective I think you actually flip-flopped the cases here. I think your slide No. 9 is correct. It says mitigation only effective in low-density cases. It was assumed not in high-density. I think when you stated it --

MR. HEACOCK: It was stated that --

COMMISSIONER SVINICKI: -- you said the opposite. I don't know if we have the capability to read back, and I'm not going to take our time with that, but I just again as a student last night --

MR. HEACOCK: That's what I meant to say.

COMMISSIONER SVINICKI: -- of reading some transcripts it's hard if you don't get that corrected because then it's not --

MR. HEACOCK: Thank you.

COMMISSIONER SVINICKI: -- certain when you're just reading it years later. So thank you. But I just wanted to get that on the record.

And then, Ms. King, you talked about research on transportation after long-term storage. I find that a very interesting topic. Could you talk a little bit about what are the parameters that are planned to be studied on that topic?

MS. KING: Well, I think the most important thing we want to look at and what we're looking forward to in the high-burnup demonstration is the integration. We've done a lot of separate effects studies on high-burnup fuel. And by loading a cask fully we can see what the integration is and whether there's any cumulative effects when you have a cask fully loaded with high-burnup fuel. Relative to the cladding what we're looking at is ensuring that we have the proper structural integrity such that it can survive transportation and any other handling activities that might be necessary either in a consolidated storage facility or in a geological disposal facility if we're going to be doing any repacking.

So given the uncertainty around final disposal for spent nuclear fuel, it's important that we understand in long-term storage what is the expected integrity of the cladding itself, because you would handle damaged fuel differently than you would handle intact cladding.

COMMISSIONER SVINICKI: And so is the basic phenomenologies of concern there have to do with materials and structural? Is that --

MS. KING: Yes. Yes, it would be materials --

COMMISSIONER SVINICKI: -- in a succinct way that's --

MS. KING: -- studies around hydride reorientation and how that happens as the fuel cools.

COMMISSIONER SVINICKI: Okay. And when you talk about long-term storage, what kind of time frames are your analysts suggesting?

MS. KING: I think at a minimum we're looking until the plants are completely decommissioning, long-term storage at plant site. We're planning that it would be within the confines of the independent spent nuclear fuel facilities we have today in dry storage. So probably 100 years, you know, if you're to bracket the fleet.

COMMISSIONER SVINICKI: And in the body of research that you've talked about either conducted or planned that you described in your presentation this morning, does EPRI work collaboratively with the international community and are you familiar or have you done work in looking at not just operating experience but how spent fuel pool hazards are evaluated or treated in kind of other international research institutions or other peer bodies that you might coordinate with?

MS. KING: Well, definitely through our Extended Storage Collaboration Program we have a broad reach out in terms of what the needs are for dry storage. In previous years we've done a lot of work looking at the safe storage within pools. I guess there has been a fair amount of risk work, but that's outside of my area really to comment on, but I could get back to you with a more complete answer.

COMMISSIONER SVINICKI: Okay. Thank you. For the cases in the NRC staff's analysis where mitigation was assumed to be effective or effective to some degree, it was interesting to hear the presentation just now that the staff assumed more of a quasi-FLEX or near to a full-FLEX capability as opposed to a B.5.b capability. Mr. Heacock, do you have any reaction to that?

MR. HEACOCK: I think the comment was based on things like the fuel availability for the security order. There's a time limit that you had to have fuel available for. With FLEX that time is 72 hours and you have the ability to refuel from off site. So essentially it's indefinite with FLEX. So there's no reason to truncate the study for the FLEX approach. So I think Dr. Lyman was correct in that the assumption may have been longer than the 12 hours assumed in B.5.b.

COMMISSIONER SVINICKI: But in your presentation you had talked about FLEX giving sites capabilities beyond what was assumed in the NRC staff's analysis for the mitigated cases. Would that be from standpoints other than the specific case you just mentioned?

MR. HEACOCK: No, and with the FLEX there's additional redundancy. For example, we have additional equipment. We have additional abilities to deliver water to the spent fuel pool that was not available with the original security order.

COMMISSIONER SVINICKI: And one other point that I would like to see if you have any reaction to was the -- I believe it was Dr. Thompson who mentioned that the cost associated with movement to dry cask storage should be considered more of an acceleration in time of a cost that will or is likely to eventually occur in the United States given the lack of progress on the final disposal location. Would you, Mr. Heacock or maybe Ms. King, do you have reactions to that statement?

MR. HEACOCK: I think Christine summed it up correctly. It's not simply a time value theory of money issue. If you have to off-load the fuel pools earlier, if the fuel is hotter and requires fewer fuel assemblies to be put in each cask, you have to short load the casks. It also has off-site dose consequences that are higher. So it's not simply a time value theory. It's the actual additional cost which Christine summarized in her presentation. That's the true cost of accelerating the off-load.

COMMISSIONER SVINICKI: Okay. Thank you. Thank you, Madam Chairman.

CHAIRMAN MACFARLANE: All right. On to Commissioner Apostolakis.

COMMISSIONER APOSTOLAKIS: Thank you, Madam Chairman. Thank you all for coming. I'm having a problem, and maybe Dr. Lyman and Dr. Thompson can help me with that.

The staff says it's not worth it. The Advisory Committee on Reactor Safeguards says we agree. The statistical evidence says these pools are very robust. Minor damage here or there under very strong earthquakes. Why would I go against the staff's recommendation with this evidence? Can you give me the top one or two reasons why I should do that?

And let me make another comment. These studies should not be reviewed as academic papers where you can make all sorts of comments about details here and there. You should have studied this. You should have studied that. It's a regulatory decision we're making here and you have to give me a reason that would upset that decision, not something that will make the study better. So if you can give me that, I'm very willing to listen, the top one or two reasons why the decision is flawed. Dr. Thompson?

DR. THOMPSON: I'll give you the top reason, and this is only one, so it's not the only reason. In the declarations that I have provided I've shown evidence that spent fuel pools and reactors are vulnerable to attack. Obviously I have not given detail on that. That would be improper. However, if you look at those declarations carefully, I believe you'll conclude that an attack achieving a spent fuel pool fire is within the capability of non-state actors. The probability of this event is numerically indeterminate, but I submit that it is significant.

And we have had attacks on the United States, as you know. The consequences of a successful attack could be extremely severe. A release of 85 petabecquerels of cesium, in the opinion of the leader of the Soviet Union, led to the disappearance of that political entity. Fallout of six petabecquerels has shut down the entire nuclear industry of Japan, among other effects. And I'm talking about potential release exceeding 2,000 petabecquerels.

COMMISSIONER APOSTOLAKIS: So your main point is the security issue?

DR. THOMPSON: You asked me for my top --

COMMISSIONER APOSTOLAKIS: Yes, your top thing.

DR. THOMPSON: That's it.

COMMISSIONER APOSTOLAKIS: So it's the security that -- yes.

DR. THOMPSON: Yes.

COMMISSIONER APOSTOLAKIS: And that was not discussed. Dr. Lyman?

DR. LYMAN: Well, I'd just like to take issue with your statement about academic studies compared to regulatory analysis. No, it's not a peer-reviewed academic study, but I think it's the Commission's obligation that their decision-making be made with regard to sound science. And if there are flaws in the regulatory analysis, it would be a mistake to make any decisions until those have been fully vetted. And given the staff non-concurrences and some of the issues that I've raised, I think those flaws really would rate a poor grade for this study for making a decision. That's why we urge you to go on to the next level.

Just taking the ACRS opinion, for example; I haven't seen their letter yet, but in the case of the State-of-the-Art Reactor Consequence Assessment, as I said, the ACRS reviewed that study very critically. You may remember that. And one of the objections was that it was taking a snapshot. What they called best estimate was pulled out of the air based on some mythical judgment. There was no comprehensive sensitivity or uncertainty analysis. The ACRS and the independent peer review said you need to do an uncertainly analysis. And so the staff took a couple of years and produced this.

One consequence in the uncertainty analysis, you may remember, in the SOARCA study, the staff trumpeted the fact that there was zero acute fatalities. That was one of the main talking points that they presented to the public. Well, in the uncertainty analysis they find out that's not true anymore. There are many scenarios where there are acute fatalities. So I would submit that until that uncertainty analysis is done you don't have the full range of information to make this decision.

COMMISSIONER APOSTOLAKIS: So the uncertainty analysis is the flaw?

DR. LYMAN: It's one key flaw.

COMMISSIONER APOSTOLAKIS: I still disagree. We are not reviewing these as academic papers. You have to tell me what will make me change the decision. What is the driver? And you're saying it's the lack of uncertainty analysis, which is a legitimate complaint.

A lot of your arguments really are based on the consequences of a release. And, Dr. Thompson, you make this interesting statement which I have to challenge. What are the ideologies that tells us that we have to multiply probability by consequences? Is it the Marxist? Is it the Capitalist? What is it? Or is it just mathematics?

DR. THOMPSON: I've discussed this issue at some length in my most recent declaration that has been provided to you. And I don't have the time to expand upon all of that, but the first question is whether you fully understand the probability and the consequences. And I submit that there are many reasons why you don't when you don't understand the full magnitude and scope of the probability or the consequences when you're talking about events such as those we describe.

And then there's the question even if you did understand it, why is it appropriate to multiply these numbers, assuming that you can even provide numbers and produce some very low combined number, and say that this is acceptable? That is not a scientific statement. It's an arithmetic statement. But a well-informed citizen in sound mind could simply say I reject that. If the consequences are predicted to exceed a certain level, I find that intolerable regardless of what the probability may be.

So when I say ideology, I'm not talking about Marxism or Capitalism. I'm talking about this presumption that we can find numbers and multiply them together and somehow this makes a dramatic outcome acceptable.

COMMISSIONER APOSTOLAKIS: Yes, I think it's a little related to what Dr. Lyman said, that we should look at the higher percentiles to make a decision because of the consequences. But surely you agree that if the probability is extremely low, like meteorite hit, the consequences, yes, they may be large, but I mean that has been a philosophical issue. You know, if the consequences destroy the world, will you still go with the probabilities? I don't want to get into that because I don't think we're in this thing.

One other question for you, Dr. Thompson. You have submitted your statements and so on. And there was a detailed response by Dr. Powers of the Advisory Committee on Reactor Safeguards. Have you read that?

DR. THOMPSON: Yes, I would like, please, to respond briefly to the statement you just made about meteor impact. That's a force of nature. Meteor impact or a volcano or whatever is a force of nature. Here we're talking about machinery made to produce electricity.

COMMISSIONER APOSTOLAKIS: Uncertainties, because we did it. Yes, I agree with that.

DR. THOMPSON: And a human-made machine that provides electricity is not anything remotely like a meteor. There are many ways of making electricity.

COMMISSIONER APOSTOLAKIS: So you are really saying that the probabilities are not on a sound footing, I mean that we produce them or the staff produce them. There may be uncertainties or there are uncertainties and so on. But can you give me a quick response, because I'm running out of time. Have you read Dr. Powers' commentary and do you agree or disagree with that?

DR. THOMPSON: Well, I've responded in my most recent declaration to his commentary.

COMMISSIONER APOSTOLAKIS: Oh, so there's a written response?

DR. THOMPSON: Yes.

COMMISSIONER APOSTOLAKIS: Okay. Thank you. I have many more questions, Madam Chairman, but --

CHAIRMAN MACFARLANE: We can have another round. Don't worry.

Okay. Commissioner Magwood?

COMMISSIONER MAGWOOD: Thank you, Chairman.

Well, good morning and Happy New Year to all of you. I haven't seen all of you since 2013.

First, I see Bob Alvarez sitting in the back back there. I haven't seen Bob in more than a decade. You look good, Bob. And Bob and I used to work here at the Department of Energy and, you know, it's a pleasure to see you still engaged in these issues. And I did see your memo on high-burnup fuel, and I'll make a point to pass it off to Research staff to make sure there's nothing in there they've missed. So appreciate you putting that list of issues together.

Obviously this is an issue that many people have been engaged in, this issue of spent fuel expedited transfer. I've heard from a variety of people and a variety of communities about this issue. It's one that for some people it's a very emotional issue because they think it's obvious that dry cask storage is safer inherently than pool storage and therefore why won't we just do that? And I think that the study, while it certainly, you know, isn't unassailable, does provide some interesting new information which I think is worth reflecting on.

And for me one thing that was kind of an interesting aha moment; and I've talked to staff about this quite a bit, was the analysis showing that the presence of the cooler fuel in conjunction with the hotter fuel, and the 1x8 configuration particularly, act as a heat sink and actually mitigated the probability of a spent fuel fire. And that's something that really hadn't come up before. So while, you know, there is some criticism of the study, I think there is some new facts that really have not been discussed before. And I don't want to dwell on the details of the study, but I think that was one thing I wanted to highlight, because I thought it was very important.

But when I think about this matter overall and I listen to the conversation at the table this morning, it sounds to me that one issue that is at the core of a lot of the concerns is this issue of mitigation. And I certainly hear from sort of the Dave Heacock side of the table that this is easy. We put water in the spent fuel pool. We're going to deal with this. And what I think I hear it from Dr. Thompson and from Dr. Lyman is, well, you know, it may not be that easy.

And I wanted to sort of start with that and maybe start with Dr. Thompson, because you presented the chart that I think -- in fact in your declaration you highlight -- there's a line that you have that says that we have ample evidence that water makeup and other mitigating actions could be precluded for periods substantially exceeding 20 hours. And I was going to ask you what you meant by that. And then I saw your slide and I realized what you meant by that is that you think that the consequences of a reactor accident could lead to an environment which I think you characterize as high as 44 Sieverts per hour. Wasn't that the number in your chart, I think? What kind of reactor accident is that and what kind of scenario is that where you would see that kind of radiation field?

DR. THOMPSON: The case I presented in my slide is described in its footnotes. And I explained to Commissioner Apostolakis that my top concern is attack, and I can think of a variety of attack scenarios that would produce a local radiation field of that nature. An accident would have to be a severe accident with a substantial loss of containment in order to achieve a similar radiation field, but that's also possible.

COMMISSIONER MAGWOOD: Okay. Well, I don't think we've seen anything like that. I don't even think at Chernobyl those kinds of radiation fields were in existence at the plant site, were they?

DR. THOMPSON: We didn't see it at Fukushima fortunately. The local radiation fields are still intense and they're precluding personal access to the immediate vicinity of the reactors to this day, but fortunately the scenario described did not play out.

At Chernobyl the nature of the explosion threw the material very high into the atmosphere, so although there were fatalities in responders, the radiation fields didn't in that instance reach the sort of levels I'm talking about. You're correct on that.

COMMISSIONER MAGWOOD: Let me ask Mr. Heacock to talk about that because the mitigation is this entire theory behind FLEX. It's the whole basis really of the staff's conclusion, I think, that no more needs to be done because of the ability to deal with a wide range of spent fuel pool scenarios.

Can you react to this and particularly in the case of say you have a joint reactor spent fuel incident?

MR. HEACOCK: Yes, thank you. There are a couple of things I'll point out here. Currently, all of the reactors, there are spent fuel pools have alarms very close to the surface of the level of the pool. So we get an alarm in the control room that the level is dropping very quickly.

In addition, as you know, the orders from Fukushima require a new and more thorough measure of level of the spent fuel pools and all the reactors that I'm aware of have chosen radar which will tell you the exact level of the entire elevation between the pool, the fuel, and the top of the pool. So you have a very fine view of the pool water level and a decay rate.

The partial drain down scenario that Dr. Thompson talked about earlier is a very slow-evolving event. You have a lot of time to react to that. The analysis shows you have plenty of time to put the water back in the spent fuel pool. There are installed mechanisms to do that in addition to B.5.b and FLEX mechanism to do that.

COMMISSIONER MAGWOOD: And what happens if you have a high radiation environment?

MR. HEACOCK: If you have a high radiation environment, because more difficult -- the NRC did evaluate the no mitigation scenario to see what that would look like for cooling. The air cooling becomes very important even in the scenario with a partial drain down. Air cooling is still very significant. And Dr. Powers points that out in his response that that can provide adequate cooling for a very long period of time.

It doesn't mean that access is entirely precluded either. One of the mechanisms we use for delivering water is a spray system, such spray system could be activated without getting up on the pool deck to do it, for example.

COMMISSIONER MAGWOOD: Point is always frustrating, we have a complicated subject and ten minutes to talk about it, but let me just in the few minutes we have left, let me just ask the whole panel for very brief comments. When you think about the particular narrow issue of the spent fuel pool safety, all of you have mentioned Fukushima at least in passing. What is the lesson of Fukushima? When you saw Fukushima, what do you walk away with in this issue?

And I'll just ask each of you for a brief comment?

MR. HEACOCK: It is not the spent fuel pools. I'm not concerned about that from a Fukushima perspective --

COMMISSIONER MAGWOOD: -- are you worried about station blackout?

(Laughter.)

MR. HEACOCK: It is not a Dominion issue. I just want to point that out here.

(Laughter.)

MR. HEACOCK: The lights are still on. It's not a spent fuel pool issue. We had concerns about that. But that was not the concern that drove the accident. It was training, location of the reactor facility and back-up or FLEX-type equipment.

COMMISSIONER MAGWOOD: Ms. King?

MS. KING: I think relative to Fukushima, we did a detailed analysis of what happened with the hydrogen explosion. I think what we learned is that there is coping time and that the spent fuel pools are quite robust.

COMMISSIONER MAGWOOD: Dr. Thompson?

DR. THOMPSON: Fukushima was a product of bad regulation, bad reactor design, and it's a wake-up call.

DR. LYMAN: In this context, just focusing on this pool number four, as you know, there was significant uncertainty during many days after the accident and the question of what would be the appropriate mitigation was there was a lot of argument about it.

I would submit that there are circumstances even with a different type of pool event where there would be -- it would be unclear what the appropriate mitigation strategy would be. For instance, if there were risk -- if there were a partial drain down, it's not clear whether you would want to restore water in the pool or not because there's a possibility it might make it worse. In other words, do you want to let all the water drain out of the pool rapidly and count on air cooling, but do you understand the thermal hydraulics well enough to make that call under uncertainty.

I mean there are a lot of studies that the NRC has done. These are heavily redacted, but it's not that simple.

COMMISSIONER MAGWOOD: It sounds like that you are supportive of the sorts of measures we've taken, the orders that were put out after Fukushima to enhance new fuel pool instrumentation that sounds consistent with your concerns.

DR. LYMAN: Yes, and we have supported that order. But again, it's the implementation of the order like with the other orders that could lead to some concerns down the road.

COMMISSIONER MAGWOOD: I am sure you will be watching us on that as we go forward. thank you very much.

Thank you, Chairman.

CHAIRMAN MACFARLANE: Okay. Commissioner Ostendorff.

COMMISSIONER OSTENDORFF: Than, you, Chairman. Thank you all for your presentations. I think hearing different perspectives and different viewpoints is extraordinarily helpful to the Commission.

Let me start out with Mr. Heacock and Ms. King, if I can, just on one specific point. There have been some criticisms of the NRC in recent months, maybe the last two years on the accuracy of some of the cost estimate data that our staff has used in looking at what it takes for industry to accomplish a given function.

Do you have any comments on the cost estimate approach used by the staff on the spent fuel pool paper?

MR. HEACOCK: In this case, the industry did not really have an issue with the cost used. It's fairly well known what the costs are of loading dry casks. Comparing that to the minor safety improvement I think was the real comparison. So we really have no issue with that in this case.

MS. KING: I would agree.

COMMISSIONER OSTENDORFF: Dr. Thompson, Dr. Lyman, any comments on the cost piece because that's been something -- the costs were not specific to this issue, but there have been some criticisms of the Agency in that area. Do you have any comments on that?

DR. LYMAN: I think there are many areas where the kind of cost analysis that's done for the regulatory analysis can be subject to question. And if you go into the innards of MAX II which is used from everything from SAM analysis to the study you see that there are many parameters that have an important impact on the conclusions that have not been revised substantially since -- for decades. For instance, the decontamination costs, that's a very critical part of the study, by the way, is the balance between land values and decontamination costs.

You can change the outcome of any calculation depending on how those are measured. And you may be familiar with the recent decision where challenge was made to particular parameters based on the fact that they came from a sample problem that was provided with the MAX II code 30 years ago and has still been -- you know, been used without reconsidering them carefully. And that's the kind of thing -- if those parameters have an important impact on the outcome, they need to be understood a lot better.

COMMISSIONER OSTENDORFF: Thank you.

DR. THOMPSON: Could I supplement. As I mentioned in my presentation, the French government agency, IRSN, has done an economic damage study for release of the DPMSI and I commend that to your attention.

I would recommend that the Commission translate that from the French into the English and have it widely studied. It's the most comprehensive cost -- consequence cost assessment of which I'm aware.

COMMISSIONER OSTENDORFF: Thank you. Let me shift -- I want to make a couple of comments here and I guess I'm going to piggyback to a certain extent on my colleague, Commissioner Apostolakis' questions that approach this panel with our responsibilities as a regulator. And the difference between a regulatory approach and in some cases and instances and perhaps a more academic approach.

I would comment that it's important for us as a regulator to adhere to our principles of good regulation. Predictability and stability of regulatory processes is a very essential element of that. And in that light, our staff, I believe, this is my personal opinion only. I'm not speaking for the rest of the Commission, obviously, here. I think the staff has done a very credible job in reflecting Commission policy in its application of the quantitative health objectives QHO analysis in this paper.

And I realize that Dr. Thompson and Dr. Lyman may have different approaches that they think might be preferable and I respect that difference of opinion. But with respect to our staff's implementation and application of the QHO approach, do you have any concerns or disagreements with how that approach was executed by our staff in this paper?

Dr. Thompson?

DR. THOMPSON: I have recommended in my presentation that two documents by the staff be scrapped. That's the consequence study and the Tier 3 analysis.

I have not studied either of those documents in excruciating detail. I've studied them enough to know that they have what I considered severe and incapacitating deficiencies.

COMMISSIONER OSTENDORFF: Those are pretty strong statements you're making, Doctor. I just would ask if there are specific inaccuracies or errors in how our staff has applied the Commission policy to use the QHOs. I think we'd want to hear that.

Dr. Lyman, do you have any response to that?

DR. LYMAN: Yes, I think I mentioned in my talk that the QHOs again are focused on either latent cancer fatalities within ten miles of a release site or acute fatalities within one mile.

Now the -- if a study actually assumes that there is a full, complete, and effective, and timely evacuation of those regions, then almost by fiat, you're going to get low risks within those areas.

So the question is does that application make sense and that's the larger question. If you're asking whether they've applied it correctly

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COMMISSIONER OSTENDORFF: The question is in the application of our QHOs, that's the constraint of the question. What errors do you see and how the staff has applied the Commission policy?

DR. LYMAN: I would say that you need to have the defensible uncertainty analysis so you understand the range of probabilities and consequences so you can apply them comparatively. And I don't think that's been done here.

COMMISSIONER OSTENDORFF: All right, let me shift over to another piece and I'm assuming that Dr. Thompson, Dr. Lyman, I'm assuming your information on the security/terrorist threat is based on information that's publicly available. Is that a fair statement?

DR. THOMPSON: In my case, that is correct. I have -- do not and have never have had any security clearance.

COMMISSIONER OSTENDORFF: I bring that up because I think you are at a little bit of a disadvantage here and I think because this is a public meeting, but a lot of people watch these and as Commissioner Svinicki noted there's a public transcript that becomes available. I feel an obligation to at least make a comment on that because you're at a disadvantage here and it's not something that I can correct or the Commission can necessarily correct.

But Dr. Thompson, several times, you made comments about your top concern is attack. These are radiological weapons, referring to spent fuel pools, and "vulnerable to attack." And I appreciate your comments. I feel the need as a Commissioner here at a public meeting to state that I respectfully disagree with your statement of the concern on terrorist attack because your statement leads one to believe there are no precautions being taken from a physical security perspective.

And again, you've not read into these programs and I respect that that you have -- there's a significant body of knowledge you are not able to access. I will just tell you that I personally have been around nuclear reactors, nuclear weapons since 1976, secured nuclear weapons on numerous Navy ships I've been assigned to and been around security responsibilities at the National Security Administration. I think there's a significant body of protection that's classified that does provide very robust physical protection for the spent fuel pools which are part of the protected area of our licensees.

And so I just mention that because I think if it is not said at this session, then the public is left with the impression that the Commission perhaps by silence is acquiescing to some statements which I understand why you're making that. You just don't have access to the information to have a more fulsome perspective. So I thought it important to make that statement on the record.

DR. LYMAN: Could I comment?

COMMISSIONER OSTENDORFF: Sure.

DR. LYMAN: Everything I said and will say is based on public information, but I have had the opportunity, I have a safeguards clearance and have the opportunity to see at least circa 2005 or 2006, some safeguards information related to physical protection and that does inform my overall view as well.

But the point I want to make which I raised and I didn't have enough time to really discuss it, is the Commission does not disclose the -- what the configuration of the pool is at discharge, how long it takes if there are licensees that cannot achieve a on1.4 configuration or it doesn't tell how long it takes until that's achieved, but it does say there's a significant increased risk until you do get to one by four and we know the public doesn't know how long that is. So we just have to take the Commission's word that there's adequate protection for that increased risk, until then.

Now if you were to transition to low-density pool, one of my slides show that there's a very significant benefit compared to a uniform configuration. And so you wouldn't have to hide that information any more. The public could have more confidence that even right after refueling you don't have an enhanced risk of release and so that in the event that there is a security event that is not successfully mitigated that there's another defense-in-depth measure to prevent the kind of large scale catastrophe that the numbers in the pool study find for uniform high-density pools.

So I think that argument itself, you can enhance public confidence without disclosing safeguards information, if you don't need to hide that number any more, how long it takes to get to one by four, even if there are licensees that can achieve it at all.

COMMISSIONER OSTENDORFF: Thank you for the comment. I'm out of time here.

Did you have a quick 15-second comment?

DR. THOMPSON: This a device for producing electricity. There are many possible devices that can perform that function. In this particular case, the public is told that this particular risk is dealt with somehow, but they can't be told how. That's a cost associated with this particular machine producing electricity.

COMMISSIONER OSTENDORFF: Thank you. Thank you, Chairman.

CHAIRMAN MACFARLANE: Thank you. I know everybody has lots of questions, so if we can go around again.

I know I have lots of questions. So with all due respect to Commissioner Ostendorff, I think that for completeness of study if you are going to consider precursors to an event at a spent fuel pool, one should consider all potential precursors and if terrorism is one, that should be considered. Of course, with all the understandings of the security that exists at reactors, etcetera. But that should be part of the analysis.

So a quick question and to just on the question of the quantified health objectives, for everybody, just quick, go down the line. Should the Commission use the quantified health objectives as a risk criteria for decisions on spent fuel management in general? Is that appropriate in your view?

MR. HEACOCK: Yes, I think it is. I'll start at this end. Thank you. I think it is appropriate. The staff chose what I believe is the best way of measuring this and compared against what they've used as standard methodologies in the past for evaluating these type of events. It's an off-site dose consequent. The quantitative health objectives measure that. So I think it's a very good measure of that.

CHAIRMAN MACFARLANE: Okay. Ms. King?

MS. KING: I see no issue and don't have -- it's a difficult item to quantify and I think it's as good a measure as any we have.

CHAIRMAN MACFARLANE: Okay.

DR. THOMPSON: The consequences could be very severe in terms of public health, environmental damage and social and political and national level economic costs and all of those should be considered and the quantitative health objectives do not do so.

DR. LYMAN: I think I've already gone on the record that we don't think it's the right metric for this particular analysis.

CHAIRMAN MACFARLANE: Okay. Are any of you aware of the practices of other countries in terms of their spent fuel management vis-a-vis pools and dry casks and the reasons that they follow the practices that they do? Are any of you aware of any other countries and their practices?

DR. THOMPSON: In my observation of the nuclear industry and regulators in a number of countries, they mostly take their lead from the NRC and that's true of spent fuel hazards and that's why in my concluding remarks I recommended that any detailed phenomenological study should be internationalized to the extent possible.

CHAIRMAN MACFARLANE: Anybody else?

MR. HEACOCK: One additional comment. We're not aware of any other country. We did look at that issue to see if any other countries had decided to prematurely offloaded older spent fuel from the spent fuel pools intentionally in the dry casks --

CHAIRMAN MACFARLANE: I know that actually, at least two countries do that, Sweden and France both offload within a year or 18 months.

MR. HEACOCK: It might be the size of their pool. Right.

CHAIRMAN MACFARLANE: But they go to a centralized pool.

MR. HEACOCK: That's a different story if it has a centralized reprocessing or centralized storage facility, it's a different facility. But if it's stored on site, we're not aware of any countries that move off intentionally from wet to dry storage.

MS. KING: That is my experience as well and we're seeing more countries implementing dry storage to keep pace with the reactor operations.

CHAIRMAN MACFARLANE: Okay.

DR. LYMAN: I do believe and just one story about this that France, the regulators, recently ordered a review of spent fuel pool safety in France, so you might want to look at what they --

CHAIRMAN MACFARLANE: Yes, I should talk to my friend, Pierre-Franck. Okay.

So let me start with individual questions. So for Mr. Heacock, so we've had some questions here about the practices of the plants in terms of spent fuel management. So tell us, is discharge of spent fuel at North Anna into the one by eight configuration as analyzed? Is that how you guys do it? You unload into one by eight? Do you unload into one by four?

MR. HEACOCK: I don't know the answer to that specifically. It's one by four is where we ultimately end up in. I don't know if it's done initially or not. We have the ability at all of our units for full core offload. In one of the questions that came up previously. And we intentionally configure the pool in advance of refueling outages to minimize the amount of fuel stored together that's hottest.

CHAIRMAN MACFARLANE: So I think it would be really helpful if industry could provide me and the public with the practices.

MR. HEACOCK: We'd be happy to do that.

CHAIRMAN MACFARLANE: Whether you all maintain full core offload or not, whether you immediately unload into a one by four or one by eight. What are the practices of the industry? It would be nice to get some facts on the table so we're not just sitting here guessing.

Let me jump to Ms. King. So should new reactors in the future store spent fuel using industry practices from the 1960s and 1970s? Or should we actually do some new thinking here?

MS. KING: In terms of whether we should stay in the pool versus dry storage?

CHAIRMAN MACFARLANE: No, in terms of whether we should use these high-density racks and whether the pools should be sized as they are, you know, whether we should be planning to move fuel out, we should be playing for dry cask storage, should we be thinking ahead, how far should we be thinking ahead? Should we be thinking about some kind of centralized storage? I mean how should we be approaching this? Should we just do what we've been doing for 50 years or actually rethink?

MS. KING: I haven't spent much time looking at new plant designs in particular. I would say that so relative to the size of the pools or those types of things I don't -- there may be someone at EPRI that has an opinion. I do not.

I think right now we are waiting for an answer on what are we going to do with spent fuel, but in the meantime the utilities and the industry, we do have a responsibility to evaluate the technology that we have.

What we see coming is everyone is discharging high-burnup fuel and we need to ensure that we understand the properties associated with the cladding and the safe long-term storage of the high-burnup fuel. Whether we should do a consolidated storage or geological disposal, there's lots of pros and cons on both sides of that.

CHAIRMAN MACFARLANE: Okay. Let me ask another question. If expedited transfer was required for fuel greater than 7 or 10 years of age, 12 years of age instead of 5 years of age, would the worker dose be as great? Can you tell me? Did you guys analyze for that?

MS. KING: We did not. We did not analyze for that, but --

CHAIRMAN MACFARLANE: Do you have an idea?

MS. KING: But obviously, the longer it cools, the dose would go down.

CHAIRMAN MACFARLANE: It's not linear though.

MS. KING: It's not linear.

CHAIRMAN MACFARLANE: That's right.

MS. KING: No, it's not linear. You know, other considerations in working with the shorter cooled fuel is that it's actually thermally hotter and you know so if we were to work with shorter cooled fuel, we need to go back and look at our fuel handling operations and ensure that our workers are safe. For example --

CHAIRMAN MACFARLANE: Let's say that we're not looking at the shorter cooled fuel.

MS. KING: Okay.

CHAIRMAN MACFARLANE: Let's say that we're looking at the -- I mean these pools have a lot of fuel in them and some is very old. Let's say we're talking about some of the really old stuff. Would you guys reanalyze for that? Did you think about analyzing for some of the older, moving some of the worker doses from the older fuel? What are some of the greatest contributors to worker dose during fuel movement?

MS. KING: I don't know the exact answer to that particular question. I think relative to contributors to the worker dose in our study, it comes primarily from the need to load additional canisters. So if you're not working with the shorter cooled fuel, and therefore not loading additional canisters, I think there is a potential that it could -- the worker dose could be lower than what we estimated.

We did not try to do any type of iteration or optimization in our study. We ran a couple of cases to understand the impact.

CHAIRMAN MACFARLANE: Okay.

MS. KING: It's something that could be looked at, obviously.

CHAIRMAN MACFARLANE: Okay. All right, let me move down the line here. So Gordon, you note that the staff doesn't look at partial loss of water that would reduce air cooling in a closed rack. The staff performed, the staff looked at these closed racks. They didn't look at what you had proposed in your first slide which was the open rack. So you know, the staff has indicated to me that recently discharged fuel could still oxidize and self-ignite even with open racks. So do you agree? And tell me, is the physics really different between open racks and closed racks? And how is the physics different, if it is?

DR. THOMPSON: In the open rack, in the event of water loss there will be three dimensional vigorous convective circulation of air and steam providing cooling to the exposed portion of the fuel assemblies. There could be some instances in which very short cooled fuel would self ignite under those circumstances. And that's one of the issues that could be resolved in the detailed phenomenological study that I have recommended be performed. But we know from fairly simple physics that that's a transient situation that only the shortest cooled fuel would be subject to self-ignition. We don't know precisely what number that would be in terms of days of cooling and that's why we would do the study to find out.

Even if such ignition were to occur, the distance between the fuel assemblies would make propagation of that fire to surrounding fuel less likely to occur. And even if propagation did occur and the entire inventory were to catch fire, the amount of cesium in the pool would be substantially less than in the high-density case. So you add all of these factors together and it's clear that the range of circumstances leading to a fire are many fewer than in the high-density case and the consequences are limited by the inventory.

CHAIRMAN MACFARLANE: I guess I'd like to see all of that quantified.

All right, I'm over my time, way over. Let me see if everybody, anybody has additional questions?

COMMISSIONER SVINICKI: If I could just note in something that's fairly unusual for the Commission. We have actually scheduled another meeting this afternoon to one I think that we're making up because of the government shutdown that occurred in October. So I would just make an appeal that if we could conduct this meeting such that we could have a break between these meetings, I think it will, I'll speak only for myself, really help my energy level this afternoon if we can have a break between these two meetings. Thank you.

CHAIRMAN MACFARLANE: George?

COMMISSIONER APOSTOLAKIS: Yes, I do. Ed, your Slide 3 says even if calculations based on average assumption suggest action is not warranted, the danger posed by high-risk outliers needs to be addressed. And you also mentioned earlier that there is a lack of uncertainty analysis. So am I to conclude from this that if we did a rigorous uncertainty analysis and looked at the high percentiles, then we would identify some of those outliers?

DR. LYMAN: Yes, hopefully that would be the point to look at those that are important.

COMMISSIONER APOSTOLAKIS: Now the staff also did, as you know, a high, medium, and low calculation. You don't like that.

DR. LYMAN: I think those were pulled out of thin air. They were based on judgment calls about certain outliers and not based on any kind of systematic methodology. In certain cases, the choices they've made, I think, don't make that much sense.

COMMISSIONER APOSTOLAKIS: Now, can I conclude from this bullet that maybe not all plants need to expedite the transfer of fuels, but there may be a few. Is that your understanding, too?

DR. LYMAN: That's not our general position, but we do -- there could be site specific aspects.

COMMISSIONER APOSTOLAKIS: Key words are site specific. Thank you very much.

CHAIRMAN MACFARLANE: Are you done?

COMMISSIONER APOSTOLAKIS: Yes. Well, I'm not.

(Laughter.)

COMMISSIONER MAGWOOD: Really, I will be relatively brief. I wanted to just ask Mr. Heacock and Ms. King, in the staff's analysis the one by eight configuration had some safety benefits and the ACRS pointed out that that's worth some consideration although in the staff's recommendation it wasn't enough to require regulatory action. Is it something the industry is looking at and thinking about?

MR. HEACOCK: I am not sure we're looking at it or thinking about it. We currently have a number of analyses done, some of which I can't talk about in here for various ways we configure the spent fuel pool to minimize any risk for loss of cooling. And some of those involve different configurations than one by four and one by eight. So there are other alternatives we look at and actually implement today, but I'm not prepared to talk about what the options are going forward.

MS. KING: That is not a role we typically take in our program with the industry in determining what configurations they're implementing in the pool. We did work with them as the transition was made into high-density racks and we focused our attention on the degradation of the boral and things, poisons that we're using the pool. So that's a little beyond the scope of what EPRI does with the utilities.

CHAIRMAN MACFARLANE: I have a question for Dr. Lyman. All right, so you suggest starting over or short of starting over let's talk about the Phase 2 study that you suggest. So should the risks of dry cask storage be holistically examined with spent fuel pools? Should we be looking at high-burnup fuel and the capability of storing that and the effects in the pool of that? Should we be waiting for a broader Level 3 PRA analysis to consider severe accidents at reactors and pools? What do you think?

DR. LYMAN: I would say yes, yes, and no. I think it's fair to evaluate dry cask storage risk. We think that that would add relatively small additional component compared to the reduction risk from pool fires. There is the issue of adequate protection against sabotage in dry casks. That's an issue being considered by the staff and we think there does need to be greater protection for dry casks, but given that we think that we still believe that there would be significant risk reduction. So that should be added on.

The issues associated with -- the practical issues associated with expedited transfer and safety issues associated with dry cask storage if I burn up are important considerations and we do think they need to be evaluated.

As far as waiting for a Level 3 PRA I don't think that's necessary, but I do think that there needs to be more systematic approach to the spent fuel fire issue in particular to look at all the fleet in a consistent manner including PWRs. We know that there's been a lot of work on PWRs. We know that there have been pool fire experiments with PWRs. We know they're even looking at other phenomena like ballooning or cladding which they didn't study in the BWR case. That work needs to be brought to bear in this analysis.

CHAIRMAN MACFARLANE: Okay. That's it for me. That's it for everybody. Okay. Then we will take a short break, five minutes. And reconvene.

(Off the record.)

CHAIRMAN MACFARLANE: Let's hear from the staff now. So I'm going to turn things over to Mr. Michael Johnson to introduce the rest of the staff and move forward through your presentation. Thanks.

MR. JOHNSON: Thank you, Chairman. Good morning, Chairman and Commissioners. Can I have Slide 2, please?

In the next 40 minutes, we'll discuss the results of the staff's analysis and recommendation for the Fukushima lessons learned issue on expedited transfer of spent fuel. I want to note it represents substantial work for the staff. That work was not done in a vacuum. It was done with consideration of stakeholder input and with extensive interaction with the ACRS. And also, it was conducted consistent with the Agency's processes and practices.

For our presentation today, Jennifer Uhle, who is the Deputy Director of the Office of Nuclear Reactor Regulation will provide a background and overview. Brian Sheron, who is the Director of the Office of Nuclear Regulatory Research will overview the spent fuel pool study.

I am also joined by several staff members who performed the analysis that we are discussing today, Hossein Esmaili, who is the Senior Reactor Systems Engineer in the Office of Research and Jose Pires, who is the Senior Technical Advisor for Civil and Structural, will talk about -- will highlight the spent fuel study approach and results. And Fred Schofer, who is responsible for the regulatory analysis in the Office of Nuclear Reactor Regulation will discuss that aspect.

Slide 3, please?

Before Jennifer begins, I want to note that the effort was broad, even though the effort was broad in depth, we focused really on answering several basic questions. And in our presentation, we'll discuss those answers in detail and this slide that is up summarizes the results.

The questions are first is the storage of fuel in spent fuel pools safe? And the answer is yes. Fukushima and other operating experience, the most recent study as well as previous studies all support and do not undermine our conclusion that spent fuel pool storage or storage of spent fuel in pools provides reasonable assurance of adequate protection. And although we didn't consider them in our analyses, the safety results or the safety benefits that came from the March 2012 orders and requests for information further strengthen our confidence in the level of safety provided.

The second question, would expedited transfer of fuel to achieve low-density storage in spent fuel pools be safer? The answer is yes, arguably, and we'll explain what we mean by that. But the answer is yes.

But the third question and the more important question is would the increase in safety as a result of expedited transfer of fuel be significant or substantial? And the answer to that is no. As we'll discuss, the increase in safety would be small compared to the increased considered by the Commission to warrant an added increment in protection above adequate protection. So the increment would be small. Said another way, the staff believes that the increment of added safety would be small such that additional regulatory action is not warranted.

The final question, would the increase likely be justified in light of the added cost? Again, no. As you will hear in the presentation, we conclude based on our analysis that used conservative assumptions that were intended to maximize the benefit of low-density storage that the increase in safety would not be cost justified and the ACRS agrees.

With that, again, we'll touch on those points as we go through the presentation. I'd like to turn to Jennifer to begin the presentation.

MS. UHLE: Thanks, Mike. First, I want to verify that everyone is on Slide 4. An important point to keep in mind today as we discuss this topic is that the Agency has a long history of studying the issue of spent fuel storage safety. The work began in the 1970s when the need to provide additional storage of fuel beyond the original pool storage capacity was first realized. The staff evaluated the high density pool storage and issued regulatory guidance for its review.

The reviews demonstrated that such storage was safe and that on-site storage was allowed through license amendment processes.

The staff evaluated high-density storage as a generic safety issue in the 1980s to evaluate changes in the staff understanding of the events affecting the storage pools, and again, in the late 1990s in relation to establishing appropriate requirements for decommissioning phase of plant operations.

A series of assessments were then performed following the events of September 11 and it led to a number of changes. One is enhanced capabilities to model spent fuel response to the loss of coolant from the pool which we took advantage of when performing these analyses. And secondly, regulatory changes involving loading patterns and mitigating strategies that were ultimately codified in 10 CFR 50.54(hh).

Following the Fukushima accident, the staff undertook the spent fuel pool study in the Office of Research and we'll discuss that in more detail later. And then finally, the evaluation of possible regulatory actions. We have documented this evaluation in the COMSECY-13-0030 which, of course, was provided to the Commission in November.

So Slide 5, please.

So going back to a bit of history, during the events of Fukushima, the staff and external stakeholders raised questions on the safety of spent fuel pools, especially since the spent fuel pools at Fukushima had high-density storage. At Fukushima, this issue was more so on everyone's mind in the early days of the accident when reliable information about the pool status was not available and there were several questions raised about the integrity of the spent fuel pools after the hydrogen explosion in the Unit 4 reactor building.

Although subsequent inspections confirmed that the pools remained intact and that the stored fuel was not damaged, the staff nevertheless proposed an item to be added to the Tier 3 list of Fukushima actions to look at any benefit associated with expediting transfer of fuel to the dry casks.

In May 2013, the staff decided to complete this assessment to support the public interactions on the waste confidence decision, although the waste confidence decision did not rely solely on the Tier 3 activity.

The second bullet on this slide. The staff developed a plan involving three phases. COMSECY-13-0030 provided the results of the Phase 1 assessment which is to help determine if an additional study should be conducted. If the results of the Phase 1 study justified that we need to do additional work, then Phases 2 and 3 of the program plan would be conducted to refine those analyses to determine whether or not any regulatory action is warranted.

So as we will discuss here today, the Phase 1 assessment is more or less a screening evaluation that used conservative assumptions to bias the results towards proceedings to Phase 2. We think that more study would show even more strongly that regulatory actions are not needed in this area and therefore, our recommendation is that we close this issue without further actions or research.

Slide 6, please.

Specifically, as part of the Phase 1 work, the staff prepared a regulatory analysis of expedited transfer of spent fuel to dry cask storage using our well-established processes. Specifically, those are regulatory analysis guidelines that are documented in NUREG/BR-0058.

Fred Schofer, to my left, will be discussing this in more detail later in his presentation.

The staff relied on information from the past several studies, the October 2013 spent fuel pool study done by the Office of Research as well as operating experience to conduct the analysis. The staff used conservative values in the analysis of several parameters to ensure that design operational and other site variations amongst the new and operating reactor fleet were addressed.

Although the assessment determined that the proposed alternative did not provide a sufficient safety benefit, the staff took the additional step to do some cost benefit assessment so that the Commission would have additional information available for their decision-making process. We believe both the safety goal and the cost-benefit assessment support our recommendation that additional study of this issue is not needed.

In its recent letter to the Commission, the Advisory Committee on Reactor Safeguards agreed with the staff's recommendation.

So Slide 7, please.

This figure here, you'll see throughout the rest of the presentation shows the overall approach and how the staff's activities build upon each other. So as Brian Sheron will discuss, as well as his staff, the spent fuel pool study that's depicted more or less in the yellow or tan section included a detailed analysis of what would occur at a particular spent fuel pool or what we call the reference plant under a severe seismic event. And used plant-specific data to evaluate the potential for the pool to be uncovered, the fuel to be uncovered and then to determine whether or not that would result in releases from the fuel and if so, the consequences in terms of public health and safety.

So the spent fuel pool included a regulatory analysis for the reference plant in what we call Appendix D to the study and that's depicted in the green section on the slide. And that used information again from previous studies to address other initiating events and conditions to assess the probabilities and consequences of a release from the spent fuel pool at the reference site. This was necessary because the spent fuel pool study focused only on the extreme seismic event.

Using the established guidance for regulatory and backfit analyses, we determined that no additional regulatory action would not be pursued typically and that there was not substantial safety benefit associated with removing older spent fuel from the spent fuel pool for that referenced plan. However, it was a reference plan and it did not represent the variations across the entire fleet of reactors and spent fuel pools. So the regulatory analysis that was provided in the COMSECY and it's depicted in the purple section on the slide broadens the scope yet again, to address the whole fleet with various plant and pool designs, various initiating events and other variables to support a generic regulatory analysis of the fleet.

Fred Schofer is the staff expert who conducted the study, the regulatory analysis aspect, and will discuss this later in his presentation.

I will now turn over the presentation to Brian Sheron and his staff and will talk in more detail about the spent fuel pool study again as depicted in the yellow or tan.

MR. SHERON: Good morning. The Office of Research embarked on the spent fuel pool study some time ago following Fukushima. The reason was that we saw that the Commission was receiving a lot of letters from the public, from members of Congress regarding spent fuel pools and whether or not the fuel needed to be expeditiously transferred to dry casks. There were no current studies using current tools that we had that had been validated and the like. And we felt that providing the Commission with a technical study would give them the information that they would need to address a lot of these questions which we felt you would probably be asked at some point. So we started the study actually even before it became a Tier 3 issue.

When we looked at it, the conclusion was it was too broad to do a full-blown Level 3 type of PRA on the entire subject. What we did is when we looked at PRAs, we saw that the primary risk comes from losing coolant to the pool and uncovering the fuel. The events that get you there are seismic which produced leaks or holes in the pool. I think most PRA studies showed the majority something around 70 to 80 percent of the risk comes from a seismic event and so we focused on looking at a beyond design basis earthquake.

It turns out that when we -- as we went into this, the issue actually became a Tier 3 issue and so the spent fuel pool study actually was now going to be an input into the Tier 3 issue. Again, the approach we used was to use a -- we used a BWR, the Mark I reactor. We chose that primarily because we had just finished the SOARCA, the State-of-the-Art Consequence Analysis Study, so we had a lot of data that was available on the plant, as well as the fuel which helped us in terms of getting started very quickly.

Again, we picked a severe earthquake which was the highest contributor. And I'll let Jose talk a little bit about the one that we picked. We used our state-of-the-art computational codes. These are codes that have been validated through a lot of experiments to represent the phenomena associated with uncovering fuel and the heat up and ignition.

As we said, we analyzed scenarios that included both successful mitigation techniques as well as no mitigation.

With that, I'm going to turn it over to Jose to talk a little bit about the structural analysis.

MR. PIRES: Thank you. We considered a seismic event with a frequency of occurrence in 1 in 60,000 per year. The review of previous studies indicated to us that damage in terms of water leakage below the top of the storage spent fuel might be possible for a severe earthquake with this frequency. That will be an event possibility that would be translated into calculation of a small probability of leakage.

This corresponds to an earthquake with a peak ground acceleration of about .7G which is about four to six times greater than the peak ground acceleration for the design basis of the power plant.

The purpose of the structural analysis was to estimate the location and size of the pool leakage, if any, and its likelihood. We developed a three dimensional finite element model of the spent fuel pool and its supports to estimate the resulting liner strains and the combination of the dynamic loads induced by the earthquake and those loads that the pool carries on a permanent basis.

The results of the analysis show that there is a high probability of 90 percent and likely higher that the liner will not tear and that water will not leak from the pool. The study also estimated conversely that there is a probability of about 10 percent that the liner would leak. And also estimates that the leak location, if a leak were to occur, would be at the bottom of the pool and the junction of the walls with the floors. So pressure drain down was not credible for this pool.

Regarding the size of the leak, the analysis estimated two conditions. One condition that corresponded to the tares on the liner spreading along the base of the walls. That was what we called the moderate leak that translated into a drain down of a few hours. The other condition was a condition in which the tares in the liner at the bottom of the walls would be more localized at places in which the liner attaches to the walls and the floors. That was what we called the small leak which would correspond to a drain down in times of tens of hours.

In addition to this, we also looked at the performance of spent fuel pools in recent earthquakes, severe earthquakes in Japan, for example, the 2007 earthquake that affected the Kashiwazaki Nuclear Power Plant and the earthquake that affected Fukushima and other power plants in that area. Those two earthquakes combined affected 20 spent fuel pools, elevated pools, and no leakage was reported for any of those plants from below the top of the spent fuel which we think is consistent with our results.

I now pass the presentation to Hossein Esmaili who will talk about the rest of the results.

MR. ESMAILI: Thanks, Jose. Slide 11, please.

This slide captures the main results of the spent fuel pool study and intends to show the possibility and the magnitude of a potential radioactive release. In the slide, the blue boxes represent cases where there is no release or where we don't predict any releases.

As Jose mentioned, and as you can see in the top left box, there is a high probability in the order of 90 percent that the liner does not leak and we do not expect a release in three days. In fact, it is going to take more than seven days to boil off the water and uncover the fuel and longer to even get to the point of a release.

Now moving to the right side of the slide on the top, in case there is a liner leakage which is 10 percent of the time, we analyzed how small and moderate leak scenarios would progress. And during the operating cycle basically taking into account variations in the decay heat level and hydraulic connectivity between the spent fuel pool and the reactor and so what we found out was that the radioactive release is possible only during eight percent of the operating cycle or after two months or within two months after the fuel was moved to the pool, even if no credit is taken for mitigation. So this is an important point.

So 92 percent of the time the fuel is estimated to be air coolable for at least three days regardless of the size and the loading, whether it's high density or low density configuration.

So now I'm going to focus on the early time during the operating cycle. This is shown in the middle of the slides where it is possible to get some release. Now for small leaks, these are the two columns of the boxes that you see on the left side of the slide. With mitigation, if mitigation is successful, small leaks do not lead to a release or even uncovery of the fuel because the make-up capacity exceeds the leakage by a factor of two. Without mitigation, small leaks generally lead to a very, very high release. And this is because the leak is slow, the fuel heat up is taking place in a steam environment that leads to steam oxidation, generation of hydrogen and finally a hydrogen explosion.

So what the hydrogen explosion does is that it causes severe damage to the reactor building, so you are losing the reactor building and any natural decontamination processes that may occur. And at the same time what happens is that once the water level leaches below the base plate of the rack that the air comes in, the air that is coming in and starts cooling the fuel, it is actually going to get to a very rapid air oxidation because the fuel is already hot, so the air is going to actually aggravate the problem. So we are going to get very, very high releases in this case. For low density cases, we did not predict any hydrogen combustion.

For the moderate scenarios, these are the boxes, the two columns of boxes you see on the right side of the slide, if there is mitigation, there is still a possibility of release of both high and low density configuration during the first week because the fuel is hot enough. This is the fuel that has just been moved from the reactor to the pool and there is not sufficient makeup or spray flow. After that time, the mitigation is successful in preventing a release. Without mitigation, the releases are generally smaller than the smaller cases because the reactor building remains intact and air oxidation is limited.

Slide 12. For the first bullet -- so for the earthquake that we studied the probability of liner leakage is low. The leak is calculated to occur at the bottom. This results eventually in the complete drain down of the pool. Some people have argued and raised the concern that this is not a limiting case because a complete drain down, the residual water prevents air from coming into and cooling the fuel assemblies. However, we believe that the slow complete drain down, the case we studied in the spent fuel pool which is actually more limiting in terms of the magnitude of the release, precisely because of the reasons I just explained in the previous slide.

Regarding the second bullet in the spent fuel pool study, the low density referred to situations where all the fuel was removed without re-racking. Our assumption at the time was that the presence of the channel boxes impede any potential or postulated cross load even in open frames. However, the insights from the spent fuel pool study showed that open frame racks, even with channel boxes removed would not necessarily prevent a radioactive release during these two months. And the way we know this is because, as I mentioned before, for the moderate leak scenario, during the first week it's still hot, that even with mitigation you are going to get some release. And in the moderate leak scenario that there is enough time that you establish natural circulation, the fuel is still hot that you get a release. So these are the two reasons that we inferred from the spent fuel pool study that the fuel is really hot.

After two months, the fuel is air coolable, even in the presence of closed frame racks. So in terms of overall probability and the timing of the radioactivity release, there is not difference between the high density and low density. However, the high density leads to high releases because of zirconium fire propagation to the older assembles.

So finally, regarding the off-site consequences, we did not predict any early fatalities because of the nature of the release. This would not generate high acute doses to cause early fatalities and because protected actions would move people out of the way.

The individual latent fatalities were also low and they do not vary much between scenarios with different significant releases because off-site protective actions would limit exposures regardless of the magnitude of the release.

Slide 13. So finally, the past spent fuel pool risk studies have shown that the storage of spent fuel pool in a high-density configuration protects public health and safety. The risk is low and what they found out in the spent fuel pool study is that it's consistent with earlier research conclusions.

In addition, the regulatory analysis has shown that expedited transfer of the spent fuel for the reference plant is not justified. And at this point, I would like to -- Fred is going to go a little bit more into that. Thank you.

MR. SCHOFER: Thank you, Hossein.

Slide 14. Jennifer previously introduced this figure and discussed the general approach and how the staff's activities built upon each other to address the issue. Brian and his staff then discussed the scope and details of the spent fuel pool study.

I performed the regulatory analysis for the spent fuel pool study reference plant. I used the information contained within the spent fuel pool study and supplemented that information with information from prior spent fuel pool studies to include an even more severe earthquake, cask drops, loss of power and loss of coolant inventory events. Dry storage casks and related industry costs are based upon the industry estimates documented in Electric Power Research Institute technical reports.

Using the reference plant regulatory analysis as a starting point, I broadened this evaluation to cover the spent fuel pool designs at other U.S. operating reactors. This required the consideration of various plants and pool designs, various initiating events, and other variables to support a generic regulatory analysis in order to determine whether regulatory actions or additional studies of this issue are warranted.

Slide 15. I performed the Tier 3 assessment in accordance with established Agency practices as described in NUREG Brochure 0058, the regulatory analysis guidelines. This includes evaluating against the quantitative health objectives as well as developing estimates of costs and quantified benefits. Using this guidance provides a consistent regulatory bases for decision-making.

The first step is to perform a safety goal screening evaluation to determine whether a regulatory requirement should be imposed based on the safety goal policy statement. The safety goal policy statement defines two quantitative health objectives which I used to make this determination. The first is a prompt fatality goal, not to exceed one tenth of one percent of prompt fatality risk resulting from all other causes within one mile. The second, a latent cancer goal is not to exceed one tenth of one percent of the sum of cancer fatality risks resulting from all causes within ten miles.

If the evaluation exceeds the safety goal screen, the second step is to perform a cost-benefit analysis. This analysis compares estimates of the net potential benefit against costs between the alternatives considered and a baseline. For this analysis, two alternatives were evaluated. Alternative 1 or the regulatory baseline would continue storage of fuel in high density pool configurations in compliance with existing regulatory requirements.

Alternative 2 which is a low density spent fuel storage alternative would require the expedited transfer of fuel with more than five years decay time to dry cask storage by Calendar Year 2019. Spent fuel would continue to be stored in low density pool configurations.

The regulatory analysis was performed to determine whether additional study of expedited spent fuel transfer is warranted. That is, to go on to Phase 2.

Slide 16, please. The safety goal screen showed that there was limited safety benefit in pursuing further study of expedited spent fuel transfer. For a spent fuel pool release, there is no expected early fatalities. Therefore, the first quantitative health objective for prompt fatalities was met.

For spent fuel pool release, the conservative latent cancer fatality risk estimate to an average individual within 10 miles of 1 in 66 million is less than 1 percent of the societal risk goal value. Therefore, the second quantitative health objective was also met.

Public health risk is relatively insensitive to the magnitude of the release due to the slow accident progression, the nature of the source term, the affected protected actions and the very low likelihood of the event even occurring. Although the regulatory analysis guidelines would normally allow me to stop the evaluation at this step, I performed supplemental analyses of the costs and benefits of adopting the low density fuel loading alternative to ascertain if further analyses were warranted.

Next slide, please. This slide provides a high-level overview of the cost-benefit analysis. The analysis grouped the fleet of existing and new licensed plants to support consideration of differences in plant arrangement and fuel inventory that significantly affect the results. The spent fuel pool study provides information related to the effects of decreased storage density and information considered generally applicable to boiling water reactors that had elevated pools, particularly for the initiating seismic event considered in that study.

Past studies, past spent fuel pool studies, provide reasonably conservative frequencies of other initiating events other than earthquakes such as cask drops and extended pool boiling scenarios and provide information regarding relative differences between boiling water reactors and pressurized water reactors spent fuel pool response to those events.

The analysis used different values for the amount of radioactive material released to the environment and the probability of successful mitigation to conservatively bias the results in support of expedited transfer.

The analysis used representative fuel inventories for the two alternative loading conditions with conservatively high release fractions for the high density loading alternative and low release fractions from the spent fuel pool study for the low density loading configuration.

Also, the analysis assumed the release frequency of the low density alternative was only 5 percent of the frequency used for the high density case due to artificial consideration of successful mitigation for the low density case.

That is, no credit for a successful mitigation was employed for the high density case. Some of these key conservatisms are highlighted on the next slide.

The influences of key variables affecting accident progression were evaluated for each plant group. For some variables such as cesium inventory, seismic hazard exceedence frequency, population and economic statistics, these values were known or could be calculated with reasonable confidence. For other variables conservative values were selected.

Since the phase one work was intended to be a screening analysis the conservative approach was justified because it eliminated the need for detailed analyses of all sites and spent fuel pool designs.

The initiating event frequencies were selected to be conservatively high to maximize calculated benefits. Liner fragilities - that is, failure of the spent fuel pool liner - were conservatively selected based on previous analyses of the response of representative spent fuel pools to seismic events and cask drops.

The spent fuel pool showed that for the reference boiling water reactor Mark I plant any leakage would occur along the bottom edge of the pool.

Therefore, for the initiating seismic event analyzed in the spent fuel pool study the boiling water reactors with elevated pools were assumed to have ineffective air cooling only 80 percent of the time.

For all other initiators for the boiling water reactor pools and all initiators for other pool configuration I assumed air cooling would be ineffective.

This assumption bounds the possible effects of partial drain down, blockage, closed cell racks and non-dispersed fuel configurations simply because I assumed if you lost water the fuel could not be cooled.

Mitigation can prevent a release from fuel that has been uncovered and its success is not affected by the storage density. Implementation of post-Fukushima orders for mitigating strategies and spent fuel pool instrumentation are expected to further enhance the capability to mitigate spent fuel pool events successfully.

Nevertheless, this analysis used a conservative assumption that mitigation would be effective and would substantially decrease the likelihood radioactive or radionuclide releases for only the low density alternative and it was conservatively assumed mitigation would not be successful for the high density alternative of the regulatory baseline.

In this manner, I biased the results to favor regulatory action of expediting fuel transfer to dry cask. As stated previously, the analysis used representative fuel inventories for the two alternative loading conditions with conservatively high release fractions for the high density loading alternative and low release fractions from the spent fuel pool study for the low density loading configuration.

Next slide please. The safety goal screening evaluation demonstrated that the NRC safety goal policy and quantitative health objectives are met with orders of magnitude margin for both current high density spent fuel pool loadings and proposed low density fuel loadings.

Based on these results, the staff concluded that there is insufficient safety benefit to justify expedited transfer of spent fuel from U.S. pools to dry cask storage.

Furthermore, the supplementary regulatory analysis to evaluate the cost benefit merits of expedited transfer of spent fuel to dry cask storage shows that for the base cases evaluated the benefits of expedited transfer are far less than the costs of implementation.

These base case analyses are adequately conservative and support the staff's recommendation that more detailed evaluations of the benefits of expedited transfer of spent fuel need not be pursued.

Slide 20 please. The staff had several public meetings and received comments related to the spent fuel pool study and the regulatory analyses and included the staff's responses and appendices to those documents.

One of the principal comments had to do with security. The staff determined that security issues have been thoroughly evaluated and appropriately - and appropriate regulatory changes have been implemented.

In response to the September 11, 2001 events the NRC undertook security assessments of spent fuel storage and pools and the NRC issued an order that required reactor licensees to develop and implement guidance and strategies intended in part to maintain or restore a spent fuel pool cooling capabilities following certain beyond design basis events.

Furthermore, following the Fukushima accident the NRC issued orders to improve severe accident mitigation capability and spent fuel pool water level instrumentation at U.S. nuclear power plants to further reduce core damage risk and spent fuel pool accident risk from beyond design basis external events.

In this Tier 3 analysis the staff compared the calculated health risks from spent fuel pools to the quantitative health objectives and concluded that substantial safety enhancement is not achieved by expediting spent fuel transfer to dry storage.

Even if the analysis were to demonstrate that the benefits for an alternative outweigh its cost, the regulatory action may not be justified based on the safety goal screening evaluation.

The slow accident progression of a spent fuel pool fire if one should occur suggests a high confidence of evacuating the public. Coupled with the low probability of an accident, this reduces the estimated public health risk to substantially less than the quantitative health objectives even if reducing that risk further can be shown to be potentially cost effective.

The ACRS commented in their December 18th letter to the Commission that the staff was too conservative by assuming that mitigation would not be successful for the high density storage alternative.

We recognize that mitigation would likely be effective for both loading configurations. However, in performing the screening evaluation I assumed mitigation would only be effective for the low density loading configuration to bias the results in favor of further study.

While engaging both internal and external stakeholders comments were raised that other alternatives should be analyzed such as more favorable loading patterns.

Although these alternatives may provide benefits near that of the low density storage alternative, they were not evaluated because the safety goal screening evaluation was not met.

This completes my presentation and I'll turn it back to Mike.

MR. JOHNSON: Thank you, Fred. For the last slide and conclusion, we end where we began with the points: the current spent fuel pools provide reasonable assurance of adequate protection of public safety, that expedited transfer of spent fuel would provide only minor or limited safety benefit, that the costs of expedited transfer of spent fuel to dry cask storage outweigh the benefits and that additional studies are not needed.

We talked about in the presentation the fact that additional studies would remove simplifying conservatisms and reduce the stated benefit therefore further bolstering I think the conclusion of the staff.

More importantly, we think additional work on this Tier 3 item would take away focus from more significant endeavors like endeavors related to mitigating strategies and implementation of that order, the flooding reanalysis for example, the seismic reanalysis and upgrades needed at the plant and work, for example, on the National Fire Protection Association 805 performance based standard for fire protection, all important safety issues currently ongoing on the part of the staff and being implemented by the industry. That concludes the staff's presentation. We stand ready for your questions.

CHAIRMAN MACFARLANE: Great. Thank you very much. Thank you all. We'll start with Commissioner Svinicki.

COMMISSIONER SVINICKI: Well, thank you all for your presentations and for the work that's gone into the topic that we're discussing today which, again, in the interests of time I know we can only talk about it at a rather high level.

On that point I'm going to ask a question. Were all of you present in the room for the first panel that spoke earlier? You're all nodding your heads in the affirmative.

Was there anything that you heard either in the presentations of the first panel or in response in the back and forth in the question and answer period?

Was there anything that you were surprised by or feel that you would like to take a moment to address if it was not addressed in your remarks that you prepared in advance?

Is there anything you'd like to clarify and I should note for you that the staff conducted and received comment on the study and I have had the opportunity to review the staff's response to comments received which was very extensive and is not something that you could discuss here today.

So I know that the staff is - I will acknowledge the staff is likely not in agreement with everything they heard on the first panel.

That's not what I'm asking. I'm asking if having heard the Q and A and the presentations there's anything that is omitted from the formal remarks that you just gave that you'd like to address or clarify.

MR. JOHNSON: No.

COMMISSIONER SVINICKI: Okay. And again I would commend to my colleagues if they haven't had a chance to do it it's a complex issue. There's a strong diversity of opinion on a number of points.

I personally have read a lot of staff comment response documents and at times the agency I acknowledge can be rather summary in its dismissal of comments.

I would contrast, I feel, in this case although there were references to earlier answers for the point of conciseness I felt that the comment response provided by the staff was very understandable, again, acknowledging that not everyone is going to agree with the staff's response to the comments that they've submitted.

So along that point the Chairman had asked in the previous panel she asked Mr. Heacock for some information on current practices for outages, pool configurations and how they go about configuring spent fuel pools.

How would you characterize in the absence of kind of a detailed licensee by licensee or station by station discussion? How would you characterize what you believe to be the staff's state of knowledge of current industry practices?

MS. UHLE: Thanks. Well, there are - after the September 11th events and when we did take a look in more detail at spent fuel pool behavior we I would say directed - that's probably too strong a word.

I'll just say that ultimately changes were made in the licensing bases of the licensees about the loading of the spent fuel pools and by a certain period of time they go into a one by four pattern and, again, it was alluded to that we cannot say exactly when that is due to the security implications.

But the analyses that were done by the spent fuel pools - in the spent fuel pool study by the Office of Research makes what they've assumed in there is pretty accurate with regard to the state of the spent fuel pool loading in the pools and those - these loading - these loading patterns are part of licensing conditions in their actual licensing bases now and, of course, the regions in their inspection procedures do check up on that.

MR. JOHNSON: And just to add a finer point maybe even it is an area of active oversight - spent fuel pools receive active oversight as Jennifer indicated by our regions. We continually watch operating experience.

We've talked about that operating experience and factored it into the work that was done today. So certainly we are actively engaged in making sure that our presumptions regarding safety of spent fuel pools are well founded.

COMMISSIONER SVINICKI: So and the Chairman had made a comment. She said, you know, we shouldn't just sit here guessing and I'm in full agreement with that.

So are you responding to me by saying that you're not just sitting there guessing and that in terms of your recommendation or the recommendation in the COMSECY that this area is not justified for regulatory action? Do you feel there's any elements of guessing in your recommendation?

MR. JOHNSON: No, Commissioner.

COMMISSIONER SVINICKI: Okay, thank you. Thank you, Chairman.

CHAIRMAN MACFARLANE: Commissioner Apostolakis.

COMMISSIONER APOSTOLAKIS: Thank you. The fact that the safety goal screening shows that these are low risk situations is used extensively and in fact on slide 20 you say that you did not consider other alternatives because they do not pass the safety goal screening criteria.

Now, if we go back to the Federal Register Notice dated September 20, 1985 where the rule is issued there is a paragraph where the Commission explains what the substantial increase in the overall protection of public health and safety means.

And you can compare that to the quantitative health objectives. But then it has a very interesting sentence. On the other hand, the standard is not intended to be interpreted in a manner that would result in disapprovals of worthwhile safety or security improvements having costs that are justified in view of the increased protection that will be provided.

So this tells me that comparing with the QHOs is not absolute. There may be other things that are cost beneficial that even though the risk is lower than the QHO maybe we should do them.

So if others justify not looking at other alternatives, which you say in 20, they are rejected because they don't pass the safety goal screening.

MR. SCHOFER: The purpose of the reg analysis I performed was primarily to look at the expedited movement of fuel, the five-year issue - perform the safety goal screen, demonstrated that it didn't meet that criteria but recognizing that there is some judgment involved went forward with the cost benefit analysis to provide even additional information with regard to whether a cost beneficial determination could be made.

With regard to other alternatives, I simply did not perform additional analyses for other alternatives because predominantly I was looking at the one issue.

COMMISSIONER APOSTOLAKIS: But there is a very strong statement in the regulatory analysis that basically says, you know, the risks are low. If you use a QHO you're not going to find any substantial safety increase.

But because we are nice guys we're going to look at cost benefit and I think that's very strong compared to what the Federal Register Notice says.

Should you be doing this because you are nice guys or because it says that alternatives should be considered even if they don't pass the screening criteria.

Now, what alternatives could those be? Could it be a different pattern in the pool which was not evaluated like the one by eight?

So I think the staff's position is that we don't need additional studies. Would that be an additional study then maybe? I think there's also another statement in the documents I have - I don't know where - that says that the Commission will encourage plants to consider these alternatives.

I don't know how the Commission encourages anybody but are these the configurations - the patterns you're referring to that maybe one by eight is beneficial and will encourage the licensees to do it? But we have not done the analysis.

Now, if we did the analysis and they turned out to be cost beneficial then we should not encourage, we should direct, correct? Am I going too far ahead or -

MR. JOHNSON: No. Just let us respond to your question.

COMMISSIONER APOSTOLAKIS: Of course.

MR. SCHOFER: With regard to the safety goal screen that typically is a proxy for determining whether you can perform a backfit for a plant specific analysis. Because it didn't pass that screen there's a likelihood that we would not pass the backfit criterion of 10 CFR 109 – 51.09.

So you have - we have that reason plus because the expedited movement of fuel would most likely have a higher benefit than the one by eight and that didn't pass, there is, again, the lower likelihood that the other alternatives would pass that screen.

COMMISSIONER APOSTOLAKIS: But the cost would be higher too.

MR. SCHOFER: The cost for a one by eight may be lower but it wasn't evaluated.

COMMISSIONER APOSTOLAKIS: Would it - should it be evaluated?

MS. UHLE: Well, I can add in pointing to research that in the spent fuel pool study they did calculate the one by eight because that was what the Peach Bottom plant, which was the reference plant, went into loading patterns of and it did show that it marginally reduced the probability of zirconium fire and large release.

But still in any case, in the case of either the low density or the high density, the first two months is the period that is of paramount importance in terms of the zirconium fire and in large release probabilities and the mitigating actions orders that we have implemented and the licensees will have implemented by 2016 call for more measures to be brought to bear in the case of a drain down event in the spent fuel pool and that likely is going to take care of that two-month time period.

COMMISSIONER APOSTOLAKIS: But if that's the case and the argument is based on the scoping study why do I find the statement somewhere else that the agency will encourage the licensees to do that?

MR. JOHNSON: Commissioner, can I just try to add to what Jennifer said? So remember, again, we were - we were looking in terms of whether or not - whether or not we should continue to phase two and phase three and so we were using our processes to help us understand substantial benefit and cost justified and we came across these additional insights, the insight regarding high density storage one by eight which was for me a new insight, very insightful.

But remember and what our position is is that when you look at that benefit if you were going to take it to its extreme in terms of looking at what 51.09 requires in terms of being able to put that in place as a requirement that benefit given, again, the low likelihood that we're talking about, giving what you would run up against when you would go to use the screening criteria you would not be able to - we're projecting that you would not get to the point with respect to one by eight that the agency would be able to require - add that requirement.

That's just our - without doing the analysis, based on the work that we've done, we don't believe that the Commission would be able to require that. That's all we're trying to indicate.

COMMISSIONER APOSTOLAKIS: But the rule doesn't say that you should apply this criteria all the time. It says, you know, on the other hand - the infamous on the other hand.

Now, I don't know if - you keep talking about the phase two and I suspect that's a lot of work. I would sure like to see a written statement maybe summarizing what you said here why going to a different pattern is not cost beneficial. You don't have to do new research but maybe pull together all the arguments.

MR. JOHNSON: Well, we would do - we would have to do that before we would propose the requirement. That's what you're suggesting is that we would do that additional work and look at a one by eight in terms of whether or not -

COMMISSIONER APOSTOLAKIS: I don't know if it's additional or what. It's additional in some sense but I mean basically you seem to have your arguments already. If I could see a set of bullets why going to a different pattern or maybe any of the other alternatives that Mr. Schofer mentioned that were not analyzed.

MR. JOHNSON: Okay.

COMMISSIONER APOSTOLAKIS: Assuming that the argument or the screening is not necessary - the QHO screening not necessary why shouldn't I do that. I'm not asking for a major treatise.

I mean, you know, something in summary. Well, not a paragraph. I mean, a set of bullets - a set of bullets.

MS. UHLE: We can concisely indicate why we feel that that's not necessary to go to the -

COMMISSIONER APOSTOLAKIS: And I never doubted that you can concisely update the bullets. Thank you, Madam Chairman.

CHAIRMAN MACFARLANE: Commissioner Magwood.

COMMISSIONER MAGWOOD: Thank you, Chairman. I think Commissioner Apostolakis beat the horse to death but I'm going to resurrect it just a little bit because I did ask the industry - portions of this morning's panel to - what the plan was for the one by eight and it is pretty clear that there really isn't a particular industry focus to do anything with one by eight at this point although Mr. Heacock did indicate there's some other things being looked at that he couldn't go into.

So as we encourage industry to look at the one by eight, again, I don't agree with Commissioner Apostolakis. I don't know what that means exactly.

I'd like to get - if you want to give me infinite time I'd be willing to take it. I'll talk all day if you'll let me.

But it seems to me that, you know, that there was a clear benefit that you found, the one by eight configuration and I - and to say - dismiss it to say that it wouldn't make the cut is something that's I think it's difficult to really conclude that because the cost might actually be very minor if it's implemented over a long period of time.

It may be very little cost. We don't know. We haven't analyzed it. What - help me out a little bit more. What's the rationale for not pursuing this in some regulatory fashion?

MS. UHLE: It goes back to the concept of is there enough of a safety benefit to warrant regulatory action and we do have - what we have the regulatory analysis guidelines points to the QHOs.

But if we were to go to a particular plant and say you must now always go into a one by eight we have to pass the backfit rule 51.09 that has very specific criteria.

And the safety benefit just isn't there because the safety benefit we know would be less than that is achievable by going to the low density storage.

So in the case of the backfit criteria which would be the appropriate regulation that governs the situation after the first thing in the backfit criteria if it's not for adequate protection and it's not for compliance then we go to a safety significance determination.

If we don't make that safety significance determination then regardless of the costs we don't go forward. Now, if we do pass that safety significance benefit then, of course, we then look at the cost benefit.

Now, of course, the Commission is always able to disregard 51.09 if so you choose but just looking at a hand waving argument, it's to us intuitively obvious that we wouldn't get that safety benefit.

COMMISSIONER MAGWOOD: So the safety benefit of the one by four configuration which -

MS. UHLE: One by - sorry. Going to the one by eight instead of the one by four.

COMMISSIONER MAGWOOD: No, the one by four we're in right now.

MS. UHLE: Oh, one by four. Yes.

COMMISSIONER MAGWOOD: That kind of analysis was not done because it was done on an adequate protection basis, correct?

MS. UHLE: Yeah. And then I would add if we were to go and develop the paragraph or two or three that's necessary in this case we would, of course, have to look at all of the regulatory requirements and the fact that we have the spent fuel pool level instrumentation order.

That is a requirement, and also the enhanced mitigation strategies that has much more equipment capacity there for sprays and that we would see that that is actually going to cut the probability of having an off-site release even further by far. So we just at this stage wouldn't be, since we're already at less than 1 percent of the QHOs we just don't expect to get there.

COMMISSIONER MAGWOOD: I mean, it does - it does - for me it raises the thought that when we ordered the one by four configuration be implemented we didn't have the knowledge that the one by eight provided these extra benefits.

I mean, you may very well have said go to one by eight after then - after implementing the B.5.b. if you'd known this at that time and you would have had greater benefit, correct?

All right. I'll have to struggle with this a while longer apparently. Let me ask you a question about the QHOs and also the use of MELCOR in analyzing the spent fuel pools.

There - I think the Union of Concerned Scientists raised a lot of concerns about this. You had some non-concurrences that raised issues and I thought the non-concurrences raised some pretty good issues that - and I read the management responses.

But part of how I read where we are with use of the QHOs and use of MELCOR and a lot of the other tools you use let me ask you, I'll direct this more to Brian, it's really because they're the tools that we have. They're the methodologies that we have available as opposed to being the ideal tools and methodologies. You're shaking your head. Do you find -

MS. UHLE: I'll just - I'll start from NRR's perspective. NRR has great confidence in the MELCOR's capability to model this scenario and I'll point to Brian to fill that in with regard to the test programs.

MR. SHERON: Yeah. I mean, we looked at it and I think MELCOR, if we had any doubts about its capabilities, you know, we certainly would have identified those and addressed them as part of an uncertainty.

But I think that, you know, our conclusion was based on the validation that we've done, particularly with some of the tests we've been running out at Sandia with the spent fuel pool, the uncovering and looking at the time to ignition and the like. We had a lot of confidence in the analysis.

COMMISSIONER MAGWOOD: And you used the MELCOR for that application. Okay. What about the QHOs? Is that the right measure to use for spent fuel pools? Let me rephrase the question.

Is it - is it the - is it the measure you would use if you had the time and resources to have other measures?

MS. UHLE: Well, I mean, we have - the agency, again, has a long history of considering this because we have been looking at spent fuel pool safety for, you know, decades now - 30 years.

It does - in the case of the QHOs they focus on public health and safety directly. So it's one measure. But then again in the cost benefit analyses we consider economic consequences.

So already there is a balance between the economic consequences and the public health and safety impact. So the QHOs is some information and we provided you additional information through the cost benefit and we show that, again, we're not cost beneficial in the base cases and even with some high estimates.

So it's - I think it's a balance. It's the right one. We are - we have a - we have a paper in front of the Commission on economic consequences and it directed - SRM directed the staff to take a look at economic consequences and we're in the process of doing that now.

If we come up with something that is more appropriate maybe we will. I, at this stage, don't know but it is what we have and we followed that although we tried to provide the Commission with as much as information as we could looking at that economic consequence piece in the reg analysis.

COMMISSIONER MAGWOOD: Fair enough. Thank you. One last question. We had a conversation in the previous panel about the reactor severe accident and spent fuel pool accident linkages.

In Dr. Thompson's presentation he had this very large radiation filled postulate that would prevent the use of mitigative measures to refill a spent fuel pool.

Is this something that the staff has? I don't know if - I haven't seen these scenarios lead to the kind of radiation fields he was quoting. But how - what's the staff's view of the linkage of severe accident - reactor severe accident in spent fuel pool mitigation?

MR. ESMAILI: Well, I mean, regarding mitigation we did analyze unmitigated scenarios precisely because we assumed and even in the reg analysis they assume for the high density cases it was all unmitigated.

So part of the reason for doing unmitigated was because, you know, if something happened at the reactor that was part of the motivation for -

COMMISSIONER MAGWOOD: Right. I'm actually less interested in how it affected the study and more how we would, as a practical matter, plan for the possibility of dealing with that scenario. So I'm actually more operationally from a regulatory standpoint how do we think about that.

MR. ESMAILI: We do have this level three PRA that's going to be looking at this issue of spent fuel pool and the reactor, you know, in more details and so this is SECY-11-0089 and the staff is already doing the analysis for spent fuel pool.

But in case of the spent fuel pool study we did consider, you know, the reactor accident. You know, either it was during the outage where, you know, the reactor and the spent fuel were connected - hydraulically connected.

So we did consider the decay heat of the reactor in that analysis and also we did some sensitivity to see, you know, if a hydrogen explosion would occur as a result of the, you know, what happened in the reactor what would happen.

So these are all documented, you know, so we - so these range of release fractions that we eventually use covers some of those reactor initiated events.

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

MR. JOHNSON: Yeah. And I think - I think - I don't necessarily am going to add to what Hossein provided but I think I take comfort in the action the Commission has already taken with respect to mitigating strategies orders that says that plants have to have mitigating strategies in place implemented to provide - to maintain and restore core cooling containment and spent fuel cooling.

I take confidence - added confidence in those actions because those actions look at a beyond design basis external event and require that licensees for those - for the suite of concerns provide protection.

So that's why I think that the Commission and its action even though, again, we didn't consider it in this analysis went a great ways towards addressing that - whatever that residual risk would be.

COMMISSIONER MAGWOOD: Very good.

MR. SHERON: I was just going to add that, you know, if you look at slide 11 it shows that the - there was a case where mitigation was not credited and that would, I think, bound that scenario where you say okay, I can't access the pool because of a high radiation field and where it came from maybe, you know, debatable.

But whether it's from the reactor or just from the pool itself the assumption was is that one could not get the mitigation features, you know, working.

COMMISSIONER MAGWOOD: Understood. Thank you. Thank you, Chairman.

CHAIRMAN MACFARLANE: Commissioner Ostendorff.

COMMISSIONER OSTENDORFF: Thank you, Chairman. Thank you all for your presentations. I wanted to commend the staff and I'll direct this to Mike for the high quality of the SECY paper presented to us on this topic.

I found it very well done. I think it's also very intellectually honest in saying here's things we considered, here's things we didn't consider.

So I think the assumptions and the parameters that framed your approach were very well laid out and I wanted to thank you for that work.

Brian, I wanted to start out with a comment that you made - your part of the presentation about the Commission receiving lots of letters and lots of public interest.

I remember discussions we had back in April and May and June of 2011 on this topic and I think we all acknowledge that at the time of Fukushima and the days afterward there was a certain amount of fog of war associated with the level in spent fuel pools and questions as to the robustness or lack thereof.

I know the SECY paper talks about the 20 plus pools that have been subjected to an earthquake condition.

From a qualitative statement is it fair to say that now, almost three years into Fukushima, we have some qualitative sense that spent fuel pools are more robust than we perhaps thought in March of 2011?

MR. SHERON: I would say we have more quantitative evidence based on the analyses that we've done. I think based even on previous studies prior to Fukushima most of those concluded that the probability of a - you know, a release from a pool was very low.

I remember NUREG 1738, which we were doing just prior to 9/11, that was the conclusion that it was - the probability was below the safety goals.

But I think the analyses, particularly like the structural analyses that we've done that actually showed where we think the failure would occur, you know, and how big it would be and what size earthquake it would actually take, you know, really helped quantify our understanding.

COMMISSIONER OSTENDORFF: Thank you. I think this next question is probably for Hossein or Jose. Somebody else please direct it.

It's really kind of a question for clarification. I think the mitigating strategies order requirements and the spent fuel pool level instrumentation order that went out in the spring of 2012 - when you are looking at the mitigation case for these scenarios is it my understanding that the mitigation understood was not assuming the FLEX had been implemented? Is that correct?

MR. ESMAILI: No, we did not consider FLEX equipment but we did make an assumption as was said earlier that, you know, that mitigation - if it's successful it would be available during the 72 hours.

But I just want to mention that, which is important, is that we did scenarios with and without mitigation. We did not quantify mitigation.

COMMISSIONER OSTENDORFF: But the mitigation scenario did not take into account some additional initiatives and requirements that we required in mitigating strategies order. Is that -

MR. JOHNSON: Correct.

COMMISSIONER OSTENDORFF: Thank you. Fred will - this is part of your presentation. I commend you and your team for performing the cost benefit analyses even though the QHO screening criteria were not met. I found that very helpful.

I think we'd have been less - significantly less well informed if you'd not done that.

MR. SCHOFER: Thank you.

COMMISSIONER OSTENDORFF: I did want to ask two questions and I believe both these went out to Dr. Lyman on the first panel and I wanted to see if you had any comments on these.

One of these dealt with Dr. Lyman's statement about we really didn't update the economic consequences piece and I understand that the sensitivity analysis that included the $4,000 per rem avoided figure is part of that sensitivity even though that's not yet been acted upon by the Commission. Can you talk a little bit more about how that was looked at and what the results were of that sensitivity analysis?

MR. SCHOFER: Sure. A little background with regard to the dollar per person rem conversion factor. This is something that we have studied for the last couple of years.

We're looking to develop a NUREG and have that provided to the commission as well as out for public comment because this work was in progress and it looked like the value would go up to, say, between $4,000 and $5,000 per person rem based upon the value of statistical life used by other federal agencies as well as an update to one of the other factors.

I included that in the analysis just to inform in case it did go forward with that regard. However, I also did it using the current value just so that we understood the sensitivity.

In general, it increased the averted doses by a factor of two. What was your other question?

COMMISSIONER OSTENDORFF: I haven't asked it yet.

MR. SCHOFER: Oh, okay.

COMMISSIONER OSTENDORFF: But Dr. Lyman did raise a concern on the lack of an uncertainty analysis approach in some aspects and I didn't know if you had any - you or any other team members had any comments on that.

MR. SCHOFER: Well, I attempted to address those uncertainties by using conservative values. I developed a base case that generally used conservative values that addressed the pools that were in each of the spent fuel pool groupings.

I also did sensitivities that varied single parameters so that you could see the impact of any one parameter might have on the answers. I also did a set of sensitivity evaluations that took all low values grouped together as well as all high estimate values grouped together to show the possible range.

When that was presented to the ACRS, for instance, they commented that the - you know, those high sensitivities were extravagantly way too high and way to conservative and that the base case was a good reflection of the proper analysis - appropriate analysis.

MR. JOHNSON: I guess just said another way, I think when we dealt with uncertainties the way in which we tried to approach those was to bound them with conservatism in the analysis to treat them in that way. That's what - that's how we handled them.

MR. SCHOFER: If I could just add one point, the - for instance, you know, there was a lot of discussion in the earlier panel with regard to partial drain down, coolability and those were really handled by doing a bounding value. That is, assuming that the fuel would not be coolable at all if you lost water inventory.

Therefore, the partial drain down situation was addressed. The closed racks were addressed. So by doing that I fundamentally, you know, took that uncertainty away by bounding it.

COMMISSIONER OSTENDORFF: Thank you. Thank you, Chairman.

CHAIRMAN MACFARLANE: Okay. Just a quick question to start off because there's been discussion about mitigation.

In your view, were the operators at Fukushima able to adequately use mitigation for Unit Four's pool? I'm just curious. Was that successful mitigation or not?

MS. UHLE: Well, it's hard to tell. We - early on we weren't quite clear - wasn't clear what they were doing. After the hydrogen explosion then they started the helicopters dumping water and they don't believe that that was successful.

The difference between I would say the United States plants and the Japanese plants is that they did not have portable equipment available and it took them quite a long time -

CHAIRMAN MACFARLANE: Portable equipment like -

MS. UHLE: B.5.b, (hh) – 50.54(hh) equipment.

CHAIRMAN MACFARLANE: Right. Okay.

MS. UHLE: So in our case the mitigation that we discussed in the study is more focused on the 50.54(hh) equipment. So that wasn't available to them and in fact Daini had quite extensive damage but the corporate TEPCO was able to provide them 16 kilometers I believe of electrical cable that allowed them to string power from an offsite line in and they didn't get that type of equipment to Daiichi. So I think that's the real difference.

CHAIRMAN MACFARLANE: Okay. Thanks. And just to go back to something Commissioner Svinicki said, I just want to clarify. Maybe I misunderstood in my discussions with staff.

But are we aware of how much spent fuel is in each reactor's pool in the country? Do we have those numbers to hand? Do we have the numbers of the burn up of the fuel to hand? Do we have the arrangements of the fuel in the pools to hand?

MR. JOHNSON: Chairman, can I - can I ask - in response to your question can I ask Steve Jones to come and tell you what we do have?

MR. JONES: Good morning. Steve Jones, Office of Nuclear Reactor Regulation. I guess what we have established in the licensing process is bounds for operation -

CHAIRMAN MACFARLANE: I know. I know we have a - I understand that we have a licensing basis for all of - for these things. But I'm just wondering whether we have to hand the actual numbers right now. My understanding was not.

MR. JONES: The exact number of fuel assemblies located in the specific pool at a specific time we would have to rely on -

CHAIRMAN MACFARLANE: Just say the amount of spent fuel in a particular pool right now.

MR. JONES: Right. We would rely on resident inspectors to establish that information if we needed it for a particular pool at a particular time.

CHAIRMAN MACFARLANE: Okay. Thanks. Thank you. Okay. Now to actual bigger questions. So in your paper on filtered vents, okay, which I very much appreciate - I thought it was a very thorough job.

You guys examined the potential benefits of filtered vents to mitigate the risks of a reactor accident, right, and you presented a number of options with pros and cons and considered accidents and backfit scenarios.

You know, you did a pretty broad study. You also considered a number of other policy factors such as defense in depth, significant uncertainties in estimating event frequencies and economic consequences, the safety value of controlling hydrogen and the margins for emergency planning and protective actions.

Okay. I thought you did a really fantastic thorough job. But in this paper you present one option in requiring a very rapid transfer of all fuel older than five years - not old, old fuel but just fuel older than five years - in all plants to dry cask storage with a brief discussion of other options that - just say that they'll come to the same conclusions - that other options would come to the same conclusions.

So I guess I'm wondering and I'm struggling with how accidents from spent fuel pools and how the risks posed by spent fuel pools and the potential large consequences in the regulatory analysis are different than the regulatory analysis of filtered vents. So can you help me understand that discrepancy?

I'm - you know, from my world I like to make sure, you know, it's parallel construction. We do the same kind of analysis for everything. So -

MR. JOHNSON: Sure, Chairman. Let me just start in and as I'm talking others can weigh in and help me. So when we were looking at the recommendation for filtration, for example, or filtering strategies remember we were dealing with inadequate protection.

We were dealing with whether the Commission should, as a part of adequate protection, require hardened vents to be severe accident capable, recognizing that if they use those vents they - the result of that venting would be potential contamination. And so we looked at that - offered those up for the Commission to support.

You know, the Commission have decisions had decisions to make about how - what options would be taken - alternatives would be taken to knock down, if you will, that - those radioactive materials that would be released as a result of the Commission action to - for adequate protection, strengthen - make those vents severe accident capable.

In this instance, again, as we've tried to - tried to say we had to - ultimately I'm going to step past where we were with respect to phase one, phase two and phase three of this Tier 3 analysis to say ultimately for backfit we've got to - if we're going to implement 51.09 the Commission can always decide not to.

But if, for the staff, if we're going to pass that test we've got to make - we've got to - setting aside adequate protection and this is not adequate protection - we've got a two-part test, significant and cost justified. And so when we look at -

CHAIRMAN MACFARLANE: And you have that with filters too, right?

MR. JOHNSON: Well, again - well, I think for filters the situation was that we were - we were making the vents severe accident capable as an adequate protection order. So the Commission had already decided that the -

CHAIRMAN MACFARLANE: Right. But whether - the decision of whether to add a filter or not was still going to -

MR. JOHNSON: Right. So the -

CHAIRMAN MACFARLANE: You still - we still did that analysis, correct?

MR. JOHNSON: So there was an analysis around how to - how that filtration might happen. So I know that hasn't probably answered your question.

CHAIRMAN MACFARLANE: Yeah. I'm just trying to - I'm struggling with why it's different.

MR. SCHOFER: Yeah. Following the SECY paper on - that you're referring to we did get direction with regard to how to address qualitative factors, which we owe you a paper on and the, you know, this year.

CHAIRMAN MACFARLANE: But there have been no decisions made on that, correct?

MR. SCHOFER: No, just a statement that, you know, you'd like more detail in terms of qualitative factors which is similar to, you know, how to address defense in depth and other considerations within regulatory analyses and how to incorporate those qualitative - that qualitative information with the quantitative numbers to come to a recommendation.

As a result, I probably, you know, used a lot more quantitative versus qualitative. There are qualitative elements that are identified as other considerations within the regulatory analyses. But I did not weigh them similar to how it was done in the containment filtering RA to factor that or bias the decision.

MS. UHLE: And I know you - I don't know if you're going to go for a second round so I'll try to be brief and that is - I mean, part of this is, I think, the staff's understanding of the spent fuel pool behavior because, you know, I counted - there was over ten studies that we've done on spent fuel pool safety and a lot of them looked at the difference between high density and low density.

So after Fukushima, and as Brian indicated with a lot of the public input, you know, we focused on, okay, getting all the fuel out of there to maximize any benefit, getting all the fuel out of there that could be placed in dry cask according to the current designs of the casks.

And so we got into that mode of thinking. The research had started the spent fuel pools study. We ended up adding it as a Tier 3 item and then during that and with the deliberations both publicly and internally other options were suggested and, again, going to the one by eight because actually we didn't recognize that would provide that much benefit.

But Peach Bottom had already done going by one by eight and so we had learned from the research work that that made a benefit and also enhancing mitigation strategies, for instance.

And so we - anyway, upon completing the calculations we looked and we said well, this is, in our minds, going to removing all of the fuel that's in five years was not enough of a substantial or not a substantial safety increase and it didn't meet - it didn't meet the safety goal.

So doing anything that was even a subset of that was, obviously, not going to, in our minds, reach that level of safety required under the 51.09 imposed on the staff.

So we didn't go into great detail and look at others but we did sit down and think about it. A number of people sat down and thought about it, myself involved, and so we just feel like we didn't need to do that.

CHAIRMAN MACFARLANE: Right. I mean, it sounds like there was - I appreciate your discussion about this qualitative factors thing which I think we can have a whole seminar on ourselves.

But so you've done a lot of - you're saying you've done a lot of work before and you sort of decided that based on all that work you didn't really need to do much more.

But I thought Brian's study was very interesting - that this one by eight result was very interesting and important and something that needs more exploration. Eric, you wanted to say something.

MR. LEEDS: Thank you. Eric Leeds, director of the Office of Nuclear Reactor Regulation.

The short answer, I think, to your question, Chairman, for why the staff recommended what it did with regard to adding filters for BWR Mark I and II containments was because the cost justification analysis was very close.

With regard to spent fuel pools the cost benefit justification wasn't even close. We can't get there.

CHAIRMAN MACFARLANE: Well, it depends on the initial assumptions, right? I mean, that's what the non-concurrence was about in part.

MR. LEEDS: The initial assumptions were very, very conservative as the ACRS also stated.

CHAIRMAN MACFARLANE: I have more questions but let's go to round two here. Nothing? I know.

COMMISSIONER APOSTOLAKIS: Well, we've had some interactions with industry recently in another context and they were making, NEI especially, a very strong argument that some of the guidance we're issuing for PRAs and uncertainties and so on there's a lot of bells and whistles that are really not necessary for regulatory decision-making.

Now we come to this study and instead of an uncertainty analysis we have this high, medium, low. When the agency has Regulatory Guide 1.200 we have a very simplistic human reliability analysis when we have very sophisticated models.

Is it time perhaps for us to go back and look at those guides and NUREGs and say wait a minute now, this is really way too much?

Even we cannot implement them. That's, I think, a very serious question here because this other initiative we have, you know, to prioritize issues according to the risk significance this becomes a major impediment.

So maybe we're overdoing it. Maybe we have a priesthood that develops the 1.200s and then the practitioners who say forget it. I mean, that's - please.

MS. UHLE: Well, I'll say that we have work underway as directed by the Commission to take a look at regulatory analyses and see across the agency how the different business lines, spent fuel, transportation and waste, materials and reactors - operating reactors, new reactors - how regulatory analyses are performed and we're doing a bit of a gap analysis to determine best practices across the business lines and we will be coming forward to the Commission in the next, I believe, six months or so with the results of that to recommend any changes to how we're doing things.

But the NUREG BR brochure, 0058, has been around for quite a long time, has had several different public interactions about establishing that.

The high, medium, and low is defined in the NUREG BR. So we're following a pretty well established program and it's really not complicated.

What gets complicated is everybody agreeing on the parameter values.

COMMISSIONER APOSTOLAKIS: But you are referring to the regulatory analysis. My question was broader. We keep issuing those reports - NUREGs, regulatory guides.

The three go into a lot of detail how to do this analysis and uncertainty analysis and then we ourselves don't use them. So there is something wrong with that.

We have to go back and think. When we develop a regulatory guide 1.200 we shouldn't have the industry in mind. We should have our own staff - can they actually implement it.

Anyway, we are running out of time so -

MR. JOHNSON: Can I just, Commissioner, just add though? You sort of - trying to weigh how I should respond to your question because I'm in great favor of moving forward with the industry in terms of improving the PRA tools for example in their application as we discussed.

But I hope you heard from us that we didn't feel inhibited by our tools to be able to do this analysis. We were well supported by our tools in this analysis. We made - we made conservative assumptions.

We were bounding in instances where we felt appropriate because we wanted to get to the point where we would know with certainty whether or not we would recommend for the Commission continuing with tier - with the remaining parts of the study.

COMMISSIONER APOSTOLAKIS: This is a long discussion, Mike, I don't want to engage in. But I think we have a staff member who wants to say something.

MR. HELTON: Don Helton, Office of Nuclear Regulatory Research. I just want to make it clear because of the context of your question the decision early on here was to not do - that a probable risk assessment was not needed in this particular case because they had been performed in the past on this subject.

In cases where we are undertaking probable risk assessments like the site level three PRA previously mentioned these things are part of the playing field.

COMMISSIONER APOSTOLAKIS: So that justifies taking high values and putting them all together? No, no, no. I disagree. Thank you.

CHAIRMAN MACFARLANE: Commissioner Magwood? Okay. Indulge me two questions. One question I asked the previous panel. I'll ask you guys too.

So do we know about international experience, what other countries do and why they've made the decisions that they have?

MS. UHLE: Yeah. We - as part of our actions we have with the Fukushima related actions we have looked at the international practices and there are three countries that, of course, look at reprocessing.

So they move their fuel a little more, I would say, timely than, say, what we do here in the United States than what the other countries do.

But all the other countries are using high density storage and with at this stage no intention of doing otherwise, from what we've heard, although we constantly interact with our international colleagues.

So we'll be looking at that.

CHAIRMAN MACFARLANE: Okay. I'll look forward to some details on that. Okay.

MR. SHERON: I was just going to add that the CSNI, and I'm the chair of that committee, was planning on doing a spent fuel study similar to what we've done.

I've kind of encouraged them to hold off until we finished ours because they could probably piggy back on that. But they plan on doing a similar study sometime in the future.

CHAIRMAN MACFARLANE: Okay. It would be interesting to know because I'm just recalling the last INRA meeting that I was at, the International Nuclear Regulators Association, where a number of folks reported on their practices and I know Canada has recently changed its practice.

So I would like to hear an update on that. Okay. And final question, so this slide that you guys showed a couple times, this tan, green and purple one, this integrated analysis that you guys talked about today.

How was this communicated to the public and when, and was the public able to comment on this overall approach.

MR. JOHNSON: Yeah. Let me start and then others will help me. So with respect to the Tier 3 plan we started off with a plan. I originally communicated that with all the Tier 3 items and then revised that plan and I don't have the specific -

CHAIRMAN MACFARLANE: Yeah, but I'm talking about the specific - you know, the two studies that we're reporting on here to -

MR. JOHNSON: And in that revised plan we talked about how we would build on - how we would - what the relationship between the spent fuel study - pool study and how we would broaden that to a generic regulatory analysis.

So that was the first written communication about that three phase process and how we were going to move from, again, the pool study to this overall decision with respect to moving forward on the Tier 3 - Tier 3 item.

We then had, as you know, two public meetings, one in August and then another meeting in September. I didn't go to the August meeting.

Went to the September meeting where we talked about issues regarding the analysis and in addition to that, as you saw, not again about the overall approach but in terms of the details of the study -

CHAIRMAN MACFARLANE: Right. So there was no - there was no opportunity for the public to comment on the overall approach. Did you want -

MR. SCHOFER: During the August meeting I went through that in great detail and there were a number of comments coming back saying how much detail I went into. That was -

CHAIRMAN MACFARLANE: Okay. But I think the August meeting was presented as a meeting on the spent fuel pool study - your study, even though it was really about your study, and your study was not available to the public. Only your study was so that was a bit of a miscommunication.

MR. SCHOFER: What it was was to describe how the study was going to be performed. So it went through the methods that I used to perform the analysis. So they did have that information available.

CHAIRMAN MACFARLANE: Okay. Any other comments? Jennifer?

MS. UHLE: Well, I would just say too that though the work that the research organization did we had thought about the need for public comment in the Office of Nuclear Reactor Regulation and because the spent fuel pool study went out for public comment and written comment and, really, the guts of or the real technical details were in that study, we believed that the public meetings, having a dialogue would - you know, back and forth would be more beneficial than actually going out for any kind of public comment as did the research group with the study - their study.

CHAIRMAN MACFARLANE: Okay. But we just had two meetings.

MS. UHLE: And we had two meetings and -

CHAIRMAN MACFARLANE: One not -

MS. UHLE: And then, of course, we had several ACRS meetings on both topics that were public.

CHAIRMAN MACFARLANE: Yeah, I know. I know. The ACRS meetings are always appreciated. Okay. Any other comments? Any final comments from the Commission? No? All right. Well, thank you all.

It was a very informative and thorough morning. I appreciate everybody bearing through the whole session and we get to do it again in an hour. So we are adjourned.

(Whereupon, the above-entitled meeting concluded at 12:24 p.m.)