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Continued Learning: The Best Defense against an Uncertain Future
Prepared Remarks of Chairman Allison M. Macfarlane
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Good morning, and thank you, Eric, for the introduction. I add my welcome to all of you who have come from near and far to participate in this year's conference. Let me also extend my thanks to the NRC staff for their hard work in putting this conference together. As you would imagine, this is a major undertaking – one that essentially begins each year on the day after the previous RIC concludes. In 2011, the day after the RIC was one we won't soon forget.

Three years ago today, we watched in horror as a massive earthquake rocked the east coast of Japan, followed by a tsunami that demolished almost everything in its path.

As the consequences of these twin natural disasters unfolded at the Fukushima Dai-ichi nuclear power plant, media footage starkly revealed the broader tragedy. Hundreds of thousands of people were displaced, separated from their families, missing, or killed. Entire villages washed away, generations of memories swallowed underwater.

Something many people believed could never happen had suddenly happened before our eyes. In a confusing, rapidly-evolving situation far outside the parameters of normal operating experience, it was hard to form a clear and accurate understanding of what was taking place. This was true even for local reactor operators in Fukushima struggling heroically with a rapidly unfolding disaster, but it was even harder for officials and regulators in Tokyo and here at NRC headquarters in Rockville to understand the event in real time. Alarming, often inaccurate claims swirled around in 24-hour news cycles.

As the Japanese began to contend with the massive humanitarian crisis that persists to this day, sizeable aftershocks made their work harder. Meanwhile, even as efforts began at Fukushima to mitigate the accident, the NRC set in motion a detailed assessment of the U.S. commercial reactor fleet. Regulators around the world embarked on similar efforts and came together for the first of many international discussions on strengthening nuclear safety in light of information from the accident.

When it comes to post-Fukushima actions, the NRC and industry can both be proud of the hard work we've done to date, to learn from this tragedy and take strategic actions to enhance safety. The NRC staff's work has focused on better positioning the reactor fleet to respond to future "unknown unknowns." We've learned and accomplished a great deal. There are some who may feel we've done

too much, and some who'd argue we haven't done enough. But, as the most safety-significant changes draw nearer to completion, we're confident that the requirements we've imposed, and the actions industry has taken, supplement an already rigorous oversight program.

Regulators and industry around the world have undertaken complementary efforts to address Fukushima's lessons. Throughout the process, it's evident that we're all reaching similar conclusions. Recently, the International Atomic Energy Agency sent an Integrated Regulatory Review Service (IRRS) mission to the NRC to look at how we've addressed post-Fukushima actions, and the team strongly endorsed our work. We've also held nearly 200 public meetings to solicit input from the public and share NRC and licensee progress. I view this as a positive example of our agency's efforts to seek and consider feedback on our regulatory programs.

At the same time, I think we must acknowledge that public confidence in nuclear safety was shaken in the days following Fukushima, and that understanding the public's concerns and addressing them will play a crucial role in keeping our reactors safe and building public confidence in nuclear technology and in state regulatory bodies.

In their best moments human beings seek out information about dangerous situations in order to anticipate and prevent future ones. And as we struggle to make sense of what's happened, we may wind up relying on less than reliable sources simply because they're the only ones available or because they're the closest at hand. The adage that "nature abhors a vacuum" bears noting here. An absence of good, reliable information can leave the door open for inaccurate, speculative, or worse, deliberately misleading information.

To me, the recent sight of a member of the public broadcasting his Geiger Counter readings via You Tube as he walked a California beach is a manifestation of the risk we run if authoritative voices are not available to provide context and answer questions people have about possible risks in their environment. Fortunately, federal and state agencies are now working to fill this void.

Yet the current environment reminds us that we need to remain vigilant as new insights and sources of information emerge. Fukushima forced us to challenge assumptions about accident severity and our approaches to maintaining defense-in-depth against the uncertainties that dynamic Earth systems pose. We're continuing to address it in a situation where new plants are being constructed while others undergo decommissioning.

For this reason, I believe that we need to continue to cast a wide net for all relevant information and carefully consider that information. A decade ago, in his annual RIC remarks, Commissioner Ed McGaffigan urged his audience to ask, "What do others know that we don't know?" and demonstrate that we're actively seeking those answers. He also reflected on the importance of avoiding situations in which we have to ask, "How could we not have seen this coming?" We would do well to honor his legacy by asking ourselves the first question and dedicating ourselves to finding the answers.

As an agency and an industry, we should continue to take advantage of every opportunity for continuous learning. In addressing the issues that arise, and doing our best to prepare ourselves for the unknown, we must continue to ask ourselves: What are other agencies or industries doing? What are other countries doing? What are we hearing from the public? What's the latest academic research telling us? We should ask tough questions and encourage healthy debate. In my view, the end result of this hard work will be the kind of thorough, robust technical analysis that's essential in upholding our

core mission. Ensuring effective safety and security will give us, and industry, the ability to navigate the challenges ahead.

First, I think we should ensure that we're taking maximum advantage of the broad range of expertise we have here at the NRC. Geology played a key role in the Fukushima accident, and Earth scientists at the NRC play a valuable role in informing our regulatory work not only by contributing their diverse expertise, but by staying plugged into the latest scientific research. In seismically active zones reactor safety depends on a deep understanding of Earth science as well as a rigorous command of the engineering. One lesson in Earth science that has broad implications for all of our regulatory work is that we need to expect change. That means periodic fluctuations in the behavior of Earth systems and evolutionary change in our understanding of those systems. Our planet is constantly changing, and there's no shortage of surprises, something regulators and operators generally aren't fond of!

For this important reason, I think we need to consider more carefully the vast geologic record in our decision-making. Events like the Great Tōhoku earthquake have happened throughout the Earth's history, and they'll happen again. Sole dependence on historical data cannot accurately characterize the range of "normal" in terms of how the Earth behaves.

The clearest example of this is the volcanic record. Based on the volume of ash ejected, we know that there have been supervolcanoes, but they erupted too long ago for us to watch. They produced volumes of ash that were orders of magnitude larger than eruptions we have observed. To help illustrate this point, this graphic shows the largest known volcanic eruption in recorded human history alongside some older, yet "relatively recent" (in geological terms) eruptions from the geologic record.

Even in just the past few decades, there have been a number of substantial advances in approaches to geologic study. Here's an example of a very recent revelation: before the Sumatra quake in 2004 that created that huge tsunami in the Indian Ocean, the scientific community didn't understand that all subduction zones – the places at which one plate is pushed beneath another – of sufficient length could generate "megaquakes" – earthquakes with a magnitude greater than 8.8. It was previously thought, incorrectly as it happens, that there were only a certain number of subduction zones where this was possible.

The seismological community had only just accepted this change in understanding a few years before the Tōhoku earthquake hit Japan, providing more evidence that the emergent understanding of subduction zones was correct. This important development occurred less than ten years ago!

Here's a related example: The scientific community only accepted the theory of plate tectonics, now common in every middle school textbook, about 40 years ago – in my lifetime as a geologist. Consider that for a moment – the currently-accepted way to study and predict earthquakes has only been around for about as long as the NRC.

The NRC addresses these realities by requiring defense-in-depth and conservative margins. In our post-Fukushima work, we're striving to anticipate and prepare for future, normal Earth events.

Now I'd like to turn to the external sources of information that add beneficial perspectives to our work. Continuing our use of the Fukushima example, the accident raised many questions for

nuclear experts from a safety standpoint: Can sites effectively respond to prolonged station blackout conditions? Are we doing enough to address multi-unit accidents? Are spent fuel pools vulnerable? How important are historical data and seismic risk modeling in forecasting potential future low-probability, high consequence events?

We've worked closely with industry to address these and many related questions, as we do for safety and security-related issues across the board. Whether it's a generic or a site-specific issue, industry feedback is essential – we couldn't craft regulations without hearing from those who must implement them.

In my view, it's also important to hear from other industries whose work may inform our own actions. For example, the material properties of concrete have implications far beyond the nuclear industry. We're focused on concrete at multiple plants, both as part of our regular aging management program and for other circumstances. Related issues with concrete have also impacted the U.S. transportation infrastructure, whether as a result of human error or natural processes.

Boston's "Big Dig" provides an example of the former, with improperly affixed concrete in the roof of the tunnel killing a motorist shortly after the project was completed, not to mention constant unpredicted problems with water leakage into the tunnel system. You may have also read about the large crack in this dam in Washington State recently. We know how to address these occurrences, both from our own industry experience and from other industries facing similar issues. When these issues arise, it reminds us why our efforts to look across industries are so important.

Another important external source of information is the public. Earlier I mentioned some of the questions that Fukushima raised for nuclear experts. The American public had equally valid questions: Will I be exposed to radiation from Japan here in the United States? Will the ocean be contaminated? Do I need to take steps to protect myself and my family? What if this accident had happened here? The NRC strives to give the public ample opportunities to provide information and input and help us demonstrate that we understand their questions and are addressing their concerns.

We also learn from the public, which further strengthens our work. Two examples come to mind. First, shortly after the Chernobyl accident, fallout from the accident literally rained down on the Cumbrian hillsides in northern England, an area rich with sheep farmers. At the time, the U.K. government initially told the sheep farmers that the levels of radioactive cesium deposited were safe because their models averaged levels of radiation. The local sheep farmers were concerned that their local landscape, with its undulating hills and valleys would concentrate the radiation in hot spots – and this is exactly what happened, with the government rescinding their previous assurances. In another example from the late 1980s in Livermore, California, the Livermore National Laboratory wanted to install an incinerator to get rid of hazardous, radioactive, and mixed waste but faced local opposition. It took a retired lab scientist, working with the local anti-nuclear group, to show the lab that their calculations of plutonium emissions had been vastly underestimated and needed to be redone.

I also want to address the importance of international engagement. Through the years, we've derived considerable benefit from information we've exchanged with our international counterparts. There are many cooperative areas to point to, from exchanging operating experience, to cooperating on licensing new reactor designs, to sending our staff overseas and welcoming other regulators onto our

staff. One good example of recent fruitful cooperation is our information exchanges on new reactor construction, in particular for the AP-1000.

When we consider international experience, such as we've done with Fukushima, it's really benefitted our resulting product. But I think we need to be consistent, ensuring that in each of our activities, we're actively seeking to understand what other countries are doing and how we might learn from one another to mutually address nuclear safety and security.

I also believe that countries with greater historical experience with nuclear technology must continue to provide assistance to countries seeking to develop a regulatory infrastructure. With a number of countries considering nuclear power for the first time, international nuclear safety and security cooperation is more important than ever. I would assert that a nuclear power program cannot succeed without a credible, effective, independent regulator.

I also believe that regulatory expertise should be indigenous. I believe the need for indigenous and independent regulatory expertise is a particularly timely consideration for countries considering build-own-operate options for adding nuclear power to their energy portfolio. Regulating from afar presents a host of challenges for even the most competent foreign regulator.

In two weeks, I'll lead the United States delegation to the triennial Review Meeting of Parties to the Convention on Nuclear Safety in Vienna, Austria. It's an important opportunity to get candid peer feedback from other regulators on how we're upholding our safety responsibilities under the Convention. This year, for the first time, we'll be taking a comprehensive look at how the Convention contracting parties have addressed lessons learned from Fukushima.

As we continue to strive for effective, credible regulation, and assist other regulators in upholding these values, our commitment to continuous learning is critical. I believe that when we demonstrate that our decisions reflect the best available information, and when we demonstrate openness to external interlocutors, it enhances public confidence. This is an objective I've embraced since my tenure at NRC began, and I continue to believe in its importance.

In my view, promoting public confidence is even more important now, as we address new regulatory challenges, such as those borne out of Fukushima, additional plants undergoing decommissioning, new reactors that will soon become operational, budget limitations, and other changing circumstances.

In reflecting on the NRC's accomplishments and challenges, it's important for us to recognize that the agency, and the industry, is in a very different place than we may have predicted even three years ago. Where substantial new construction was previously predicted, industry is now assessing the evolving economics of power production, and, due to a number of factors including the recession and the low price of natural gas, facing new realities.

In this regard, I must emphasize that the NRC is cognizant of economic realities and constrained budgets. The EDO has a five-year review underway to assure there is alignment of mission responsibilities with resource allocation and organizational governance, and he'll address this in more detail in his remarks. We're focusing our energies and resources on the most safety-significant issues and re-aligning our efforts when appropriate to ensure we're operating in the most effective and

efficient manner possible. I'd like to recognize Mark for his hard work and the strategic vision with which he's leading the staff.

Regardless of what the future holds for the nuclear industry, the NRC will not become complacent. Our paramount responsibility is to ensure the safety and security of our licensed facilities. While ensuring that our mission is achieved, hearing from a variety of external audiences will continue to demonstrate that we're also carefully considering the impacts these realities are having on our licensees, and on the public. We don't make regulatory changes lightly.

We're committed to ensuring the soundness and long-term durability of our post-Fukushima actions – with the ability to prioritize and smartly adjust to new information, unexpected bumps in the road, or new ideas that the industry or the public may have to enhance safety. Just as we did after Three Mile Island, September 11, and other significant events, we must take what we've learned and make it sustainable, so that the changes we've implemented can have long-ranging safety benefits. We must also ensure that our agency, and those we regulate, are prepared for whatever comes our way. We must continue to demonstrate that our plan of action is sound.

In closing, let me emphasize that the NRC is fully committed to protecting the public's health and safety. This commitment extends to our day-to-day regulatory responsibilities and to specific efforts like implementing lessons learned from Fukushima. I believe we must all recognize that we sit at a pivotal point in our history; a moment that calls for reflection and openness to change.

Whether driven by safety and security considerations or different workload demands than projected, our resiliency as an agency will be challenged. In my view, continuing our commitment to expand our knowledge and our engagement is essential in ensuring our success in this changing environment – and I believe it will foster continued public confidence.

As we reflect today and in the months ahead – and in particular on the terrible events of three years ago that set us on our current course – I want to share a Japanese proverb: “fall down seven times, stand up eight.” In this spirit, I commend the Japanese people for their courage, their resilience, their commitment to strengthening safety both in Japan and worldwide, and their willingness to share what they've learned with us.

Thank you.