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SPEECH OF DR. DALE KLEIN TO IEEJ, TOKYO, MARCH 30, 2015

## THE LESSONS OF THREE MILE ISLAND

It is a great privilege to be invited to speak to you today.

I want to express my thanks to IEEJ's Chairman and CEO, Mr. (Masakazu) Toyoda, and to the leadership of this important organization for the wonderful welcome you have provided.

This month, we observed the fourth anniversary of the Great Japan Earthquake and tsunami.

For all of us, and especially for the people of Japan, the memory is fresh and for so many families who lost loved ones or their homes in the earthquake or the tsunami that followed, the loss is profound indeed. Japan's good friends in the United States stood with you after 3/11, and we remain standing with you today, four years later.

The resilience the Japanese people have shown in recovering has been impressive and inspiring.

I have been honored to play a small role in the effort to recover from 3/11. As you know, I am the chairman of the independent advisory group that was assembled to monitor TEPCO's progress under the Nuclear Safety Reform Plan it adopted back in 2012. We meet on a regular basis to review TEPCO's progress and provide our views, providing praise for progress when it has been earned, and pressing for more progress when we believe TEPCO needs to be pushed a little harder.

Most often, there is a bit of both, which, frankly, is to be expected when confronted with a task as complex as remediating Fukushima Daiichi while at the same time preparing the Kashiwazaki-Kariwa facility to be restarted.

As Japan progresses in the Fukushima cleanup and wrestles with the role that nuclear will play in its future, it will need to sort through many of the same political, regulatory, economic, and technical issues that we faced in the United States after the accident at

our Three Mile Island facility in 1979.

For that reason, I have been asked to share with you my reflections on the TMI experience and how they may inform the answers to the questions you are dealing with today.

I realize that TMI wasn't as severe as the Fukushima accident – it has been rated a “five” on the International Nuclear Event Scale, while Fukushima has been rated a 7. But many of those issues that we faced are, in fact, similar to the ones Japan has faced and continues to address.

### The Three Mile Island Accident

Almost all accidents – whether involving nuclear power plants, airplane crashes, or anything else – are the result of a cascading series of failures.

Certainly that was true at Fukushima, and it was also true at Three Mile Island. Both accidents ultimately involved a failure of cooling systems, but the road to that failure was quite different.

At Fukushima, of course, the accident was preceded by, and caused by, a massive natural disaster with tragic consequences – the Great Japan Earthquake and the tsunami it spawned. But the Three Mile Island accident had its genesis in a remarkably everyday event: the cleaning of a filter.

The filter itself wasn't part of the cooling system, rather it was part of the water and steam loop in one of TMI's two pressurized water reactors. This was a routine task, but as luck would have it that night, the filter proved especially difficult to clean. One thing led to another and a small amount of water found its way into an instrument airline.

This, in turn, led the feedwater pumps that delivered water to the steam generators to shut down, shutting the turbines themselves down. To handle the decay heat that was still being generated by the reactor, three auxiliary pumps activated automatically. But – and this was critical – valves had been closed for routine maintenance and those pumps couldn't pump any water.

Heat and pressure increased as a result and a relief valve that should have managed

this event malfunctioned leading to a partial meltdown of the reactor core.

The failure of the auxiliary pumps because of the valve closure was later cited as a major factor, and it was a violation of existing regulations.

The Nuclear Regulatory Commission's rules had required the reactor to have been shut down if all three of the valves were shut for maintenance. But there were also human errors and, as it was later discovered, problems in the design of the user interface that led to operational confusion about what was happening, making an effective response more difficult.

It was not until 165 minutes after the start of the problem – nearly three hours – that radiation alarms activated as contaminated water reached detectors. By that time, radiation levels in the coolant water were around 300 times expected levels.

Communication with the public and with local governments by the local utility became a source of criticism – I know this will sound familiar to you, and it is one of the reasons our Nuclear Reform Monitoring Committee has made improving communications an integral part of our recommendations.

Information was shared in a fragmented way, and claims that no radiation had been released were contradicted by instruments both at the plant and off-site. So, even though the radiation levels were unlikely to threaten public health, trust and confidence were severely eroded.

Indeed, the NRC in Washington DC had some difficulty obtaining accurate information, and an NRC historian has written that the degree of core melting wasn't known for years.

One problem TMI avoided that Fukushima unfortunately has had to deal with was a hydrogen explosion.

Although a hydrogen bubble formed in the dome of the pressure vessel, it was managed in several ways, part of which included very controversial venting into the atmosphere.

I want to share with you three other important aspects of the Three Mile Island accident before sharing with you my thoughts on their implications for the challenges Japan is dealing with today: the question of evacuating the local population, the cleanup effort, and estimates of the health impact.

In large part because of the mistrust and poor information that was provided, the governor of Pennsylvania, on the advice of then-NRC Chairman Joseph Hendrie, advised evacuation of pregnant women within a five-mile radius of the facility, and that was soon extended to 20 miles.

Approximately 140,000 people left the area, but more than half remained and 98 percent returned within three weeks.

As for the cleanup, the reactor was decommissioned and officially not completed until 1993 – 14 years after the accident. It helps us understand why the Fukushima decommissioning time scale is measured in decades.

Epidemiological studies have concluded that the accident has had no observable long-term health effects due to any radioactive releases. As you know, activism, politics, and the inherent uncertainties of statistical analysis means that some people will always believe that the health impacts were greater than they were. But the reputable studies say otherwise.

I do not want to dismiss the impact of emotional distress that people may have suffered but the fact remains that the radioactive releases from TMI had no discernable health effects.

#### The Impact, and Lessons, of Three Mile Island Impact

I know that you are particularly interested in how our regulatory apparatus and nuclear industry responded to the accident, and I will share that with you in a moment. But first I want to share with you the impact this accident had on public opinion about nuclear energy, which in turn was critically important in shaping the governmental response.

As luck would have it, the accident took place only 12 days after the release of a Hollywood movie called “The China Syndrome,” starring Jane Fonda and Jack Lemmon – two big movie stars, and Jane Fonda already had a reputation as an anti-nuclear activist.

The movie’s message was that the industry couldn't be trusted to run these plants safely, and the TMI accident played directly into that narrative. A large anti-nuclear movement took shape, with hundreds of thousands of people participating in New York City, Washington, D.C., and elsewhere.

This, together with a more stringent post-accident regulatory environment and other factors led to a steep decline in the U.S. nuclear industry. The number of reactors under construction in the U.S. declined every year from 1980 to 1998.

Fifty-one reactor orders were canceled from 1980-1984, and of the 129 nuclear power plants that had been approved prior to TMI, only 53 were completed.

Perhaps understandably, the regulatory pendulum did indeed swing too far towards over caution.

At the time, the U.S. Nuclear Regulatory Commission was a relatively new agency, created by legislation in 1974 that split the functions of the former Atomic Energy Commission into two separate agencies: The NRC, an independent agency to regulate safety, and the Energy Research and Development Administration, which ultimately became the Department of Energy.

The NRC was not created in response to a crisis, but like the JNRA it was a new agency under considerable pressure to act and to demonstrate its independence and its power. As it tightened regulatory requirements, in my view it went too far in making regulations rigid and prescriptive rather than performance-based.

Its regulatory framework was not risk-based and therefore lost sight of what was important. With everything of equal importance and urgency, there was not enough sense of priority, of focus on what is important to safety and what is not. I find this to be the current situation in Japan.

Just for one example, the NRC's post-TMI regulations required lots of training for people who had nothing to do with safety. Now, training is a very important component of safety. At my time as NRC Chairman, and more recently in my role as chair of the Nuclear Reform Monitoring Committee, we have placed a great deal of emphasis on training.

Certainly a lesson of TMI was that better training was required to increase skills and clarify accountability. But it makes sense to focus that training on the people who are, in fact, responsible for safety of the plant and the environment.

#### Lessons

Ultimately, the NRC recognized that the pendulum had swung too far, and it adjusted its course. It began to recognize, as I have often said, that "the safest airplane never flies, and the safest car never moves." Regulations started to become based on more reasonable risk analysis.

Emphasis was focused on those things that are truly critical, including the total loss of electrical power, which as we know is what happened at Fukushima Daiichi.

Second, it is important that the regulator be science-based. This is more difficult than it sounds.

After all, we live in democracies where regulatory agencies are answerable, to one degree or another, to elected officials. And even educated members of the public are liable to be confused by conflicting assertions about the safety of nuclear power or the severity of a particular event.

It's worth remembering that neither TMI nor Fukushima Daiichi had significant health implications related to radiation, but they did have significant impacts on the public's emotional stress – and that stress, whether founded on sound science or not, has real implications both for health and for the political and regulatory environment.

So what can we do to help regulations be science-based? We must understand that for the general public, radiation is frightening because it is mysterious and invisible. The

experience at Fukushima has, unfortunately, made this even more so. The answer must be a sustained informational programs that involve the government, universities, and the utilities themselves.

What is essential is that there is a source of information that is trusted by the public as honest and independent. And the information must be presented in ways that can be grasped by non-scientists, comparing radiation exposure levels to experiences in their everyday lives – for example, their exposure to radiation in an airplane ride or from eating bananas.

There are some excellent materials that have been produced along these lines, but we need more, and we need more sustained efforts to get this information to the public.

Japan may have a better chance to keep a scientific focus at its regulatory agencies than we did in the U.S.

As you may be aware, the regulatory apparatus in the U.S. is very heavily influenced by lawyers and by the potential for litigation. That is a considerably less significant factor here, and I am hopeful that the scientific rigor and discipline necessary for effective regulation will prevail.

One of the most important lessons the nuclear industry learned from TMI was to avoid excessive regulation by sharing best practices and essentially regulating itself.

I know that many may be skeptical that the nuclear industry can self-regulate but I challenge those skeptics to look at the Institute for Nuclear Power Operations (INPO), their relationship with the NRC and their common goal of excellence in safety. This is an area where I believe Japan can do better.

Industry has much more operational knowledge than regulators, and effective cooperation – under appropriate regulatory supervision – can be a lot more effective than regulation.

JANSI – the Japan Nuclear Safety Institute – has an opportunity to help all the nuclear utilities to share best practices and take on this self-regulatory role.

But, and I say this as a friend, it remains a work in progress. There is too much mistrust among the various utilities. They are not sharing as much information as

they should and will not benefit from each other's lessons learned. I remind you that the sequence of events that occurred at TMI was not new and was known.

About 18 months before TMI a very similar accident sequence occurred at the Davis Besse Plant. The operator recovered from the initial failure and the plant suffered no damage. But the plant operator did not share this information with the industry and therefore operators at TMI were not aware and not trained to recover from this type of failure sequence.

When it comes to nuclear safety information there are no barriers, there are no borders, there is no competition, and there is only the common goal of advancing the safety of nuclear technology. Japan must embrace this and I hope that some of you will be able to help that process.

No matter how effectively we prepare, or how thorough the regulatory regime, nuclear power plants are complex systems and unexpected events are inevitable. But they need not become crises. One of the results of the Three Mile Island accident was an evolution in the way we think about how and why things go wrong.

We have stopped looking at them as isolated equipment malfunctions, operator errors, or acts of God. We now understand that the prevention of major accidents lies in preventing the inevitable unexpected event from cascading into a major crisis. So we now think about "defense in depth."

While part of that involves multiple layers of backup and technical systems, an effective organizational and management system can make a decisive difference.

For that reason, the Nuclear Reform Plan that TEPCO is implementing, and whose progress our Committee is overseeing, focuses extensively on management and organizational reform.

These reforms, which, taken together constitute what we refer to as a "safety culture," are not easy for a large organization to embrace. I believe they are especially difficult for companies accustomed to a top-down, rule-oriented management culture.



To be successful, it is essential that we enable employees to think on their feet and react quickly and effectively, and empower them to put safety first and to speak up when they see a problem.

TEPCO is making progress in its adoption of a safety culture, though we have impressed upon them the importance of not letting up and of ensuring that it extends throughout the organization and down to the very front lines of the workers.

### Conclusion

So those are the lessons that I believe we learned from TMI, and some of their implications for Japan as it travels its own journey in deciding on the future of nuclear power. In many ways our experiences were quite different: Fukushima, aside from being a more severe accident, followed a major natural catastrophe that led Japan to shut all its other nuclear power plants.

So you face a decision that we did not, which is what to do with the plants you already have, let alone the ones you might build in the future.

And, 2015 is not 1979.

We now have a greater understanding of the role fossil fuels are playing in climate change and the beneficial role nuclear power can – I believe must – play if we are going to meaningfully reduce carbon emissions. Indeed, some of the environmentalists who were most vocally opposed to nuclear power in the aftermath of TMI now favor it as an alternative to fossil fuels.

I have great respect for the fact that this must be a decision for the people of Japan alone. I would not presume to say what Japan should do. But I will say that there are significant economic, environmental and security implications of that decision, and they are not limited to Japan.

Japan is one of the most important members of the global economic community and continued reliance on fossil fuels imported from other countries will have negative economic implications for the country, and will contribute to carbon emissions.

In 2013, Japan significantly scaled back its emissions targets to a 3.8 percent cut by 2020 versus 2005 levels, backing away from the previous target of a 25 percent reduction. At the time, the shuttering of Japan's nuclear power plants was cited as the main reason for the less ambitious targets.

Without those nuclear plants, Japan will continue to depend on fluctuating prices for fossil fuels, and dependent upon importing them from some very unstable places. That represents a security risk for Japan, as well as for its friends in the U.S. and elsewhere that rely on Japan as a country of stability and democracy in this part of the world.

A decline or abandonment of nuclear power in Japan would also send an unfortunate signal to the rest of the world. It will make fighting climate change more difficult. And it would have a major effect on the world's nuclear infrastructure.

Many nuclear components are made here in Japan by such companies as Mitsubishi, Hitachi, Toshiba and Japan Steel Works, which heavily depend on their domestic market.

But I remain an optimist. I have been deeply impressed by the resilience and determination of the Japanese people.

And I know that your organization will continue to play an indispensable role in conducting research and providing data, information and reports that are essential for the formulation of good policy. With the contributions that you and others are making, I have every confidence that, in the long run, Japan and its people will meet the many challenges ahead, and prevail.

Thank you very much.