

Some Thoughts on the Nuclear Energy After March 11, 2011¹

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Good morning ladies and gentlemen!

It is a great pleasure for me to be invited to provide some thoughts on the nuclear energy in today's environment. Before I begin, I would like to thank the Japan Atomic Energy Agency for organizing and hosting this 6th International Topical Meeting on High Temperature Reactor Technology and I would like also to express my sincere gratitude and a hearty welcome to you and those who have come from abroad to attend this conference, in particular.

I believe that one of the greatest challenges of this century will be to create additional safe, secure and environmentally sound energy sources. I understand you, representatives of a tremendous scientific and engineering capability highly motivated toward this energy challenge are here to discuss and exchange the latest results of research and development activities for realizing a low environmental impact nuclear energy source utilizing HTR concepts.

As Chairman of JAEC, I spent most of my time still on the issues related with Fukushima Daiichi accident. Therefore my thoughts this morning, though they are personal nature, will be limited to the course global nuclear energy community should take up in response to Fukushima, after commenting on the causes of severe accident there and an innovative strategy for energy and environmental policy recently established by the Japanese government.

Severe Accident at Fukushima Daiichi NPP

As you know, March 11, last year, the Great East-Japan Earthquake and the resulting tsunamis hit people and facilities including nuclear power plants located on the Pacific coast of Japan. This caused a severe accident at the Fukushima Daiichi Nuclear Power Plant of Tokyo Electric Power Company (TEPCO) that was unprecedented: the

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simultaneous progression of severe accidents at multiple units and the continuation of significant radioactive releases over an extended period of time.

The fact that this accident has raised concerns about the safety of nuclear power generation around the world is a matter that Japan takes with the utmost seriousness and remorse.

In the face of this hardship, Japan has received warm-hearted supports and expressions of solidarity from around the world, for which I would like to express Japan's sincere gratitude to you.

The aftermath of this earthquake and tsunami is about 18K deaths, 6K injured and 3K missing. Evacuees are about 326K people in total. As for damages, about 129K houses were completely destroyed and 265K houses were half destroyed. The cause of this magnitude of the calamity is the magnitudes of this natural event was that of once in 1,000 years and only 40% of the coastline was lined with anti-tsunami seawall, some of which was washed over its top by the tsunami as the return period of the design base tsunami for these seawalls was less than 1,000 years.

In the case of Fukushima Daiichi NPP that was hit by the earthquake and tsunami, lost were off-site power, ultimate heat sink and EDGs and in some cases, even DC power sources. Delay in containment venting and coolant injection due to insufficient preparedness for severe accidents in such situation caused fuel meltdowns, hydrogen explosion in the reactor buildings and significant radioactive releases to the environment.

The root causes for this severe accident are;

- a) Nuclear regulator and operators were shy with probabilistic approach and failed to let the experts in tsunami know the necessity of having information about the magnitude of tsunami of which return period was around 10,000 years.
- b) They also failed to satisfy the need for defense-in-depth features that should prevent a disproportionate increase in radiological consequences from an appropriate range of tsunami and flooding more severe than the design basis ones:
- c) Utilities and vendors made decisions to deviate from the accident management strategies developed by the US BWR Owners Group: regrettably, measures introduced were based on the assumption that a loss of all AC power would not last for more than 30 minutes and that the coping time could be extended up to eight hours using station batteries:

- d) Emergency trainings were superficial and did not contribute to build the preparedness for severe accidents that require venting of containment vessel in diverse situations.

Based on such understanding, Japanese nuclear regulators asked operators of all nuclear facilities immediately after the event to take the following actions before restarting from shutdown for periodic inspection and refueling;

- a) Ensure that design base external events including seismic, seismic-tsunami and other events, and their combined effects are properly evaluated.
- b) Ensure that extended losses of power and ultimate heat sink are covered under severe accident conditions and protection is provided by a diverse and flexible capability to provide power and cooling:
- c) Ensure the severe accident management procedures, including reliable hardened vents for specific reactor containments, that take into consideration of the fact that external events might affect the entire site and training thereof are in place:
- d) Ensure emergency preparedness capabilities are in place and available even under combined effects of natural events.

At present about 80,000 peoples are still requested to be out of hometown and about the same number of peoples have made choice to leave home from the fear of exposure to radiation. Some of them are suffered from a psychological agony due to fear of radiation, separation of family, disruption of communities etc. 11 municipalities are designated as special decontamination area where the Government is promoting decontamination to reduce annual additional doses below 20mSv in two years in consultation with residents.

One of the biggest issues in this activity is to establish consensus about the appropriate level of decontamination of forest that covers more than 70% of their land in average, as well as the location of decontamination waste storage facilities. Three municipalities have decided that they would not return to hometown for five years based on the regional heterogeneity of radiation level to be expected to remain in their area after the decontamination activities in two years.

Trades of agricultural and marine products in the neighborhood of the plant are still restricted. Damage compensation is estimated to be at least about 6 trillion yen (70 billion US\$) at present. It should be also emphasized that though anyone has not been hurt by the radiation, the accident has caused several hundred deaths due to the worsening of diseases owing to dislocation, including emergency evacuation from hospitals and the stress of life in a shelter after dislocation.

The electricity consumption in July this year in Japan was 6.3% less than last year owing to people's understanding of the need for energy conservation. However, as only two NPPs are allowed to restart after refueling and inspection outages, the expense of electric utility companies for fossil fuel in this year is expected to be at least 3 trillion yen (40 billion US\$) larger than that in 2010. If they are shifted to the rate, the rate will be gone up by 20% or so.

Innovative Strategy for Energy and the Environment

On September 14, the Energy and Environment Council of Japanese Government submitted to the Cabinet a document titled "Innovative Strategy for Energy and the Environment". The document was the result of the Council's deliberation started last September on a new medium- and long-term strategy for energy and environmental policy that aims at reducing dependence on nuclear power, while pursuing the goals of both assuring economic and stable supply of energy and reducing GHG emissions.

After deliberation of possible policy options, the Council solicited comments from the public and held many local meetings in July, putting three energy scenarios before them: the scenarios were called the 0%, 15% and 20-25% options, representing the portion of electricity that would come from nuclear power in 2030. The Council concluded based on the result of the consultation that at least more than 50% of the general public want to realize a society that does not depend on nuclear power in the near future.

The pillars of the resultant strategy for energy and environmental policy are:

- I. To realize a society not dependent on nuclear power in earliest possible future by
 - a) strictly applying the stipulated rules regarding forty-year limitation of the operation, b) restarting the operation of idling nuclear power plants, as an important power source, once the Nuclear Regulation Authority gives safety assurance and c) planning no new construction of a nuclear power plant;
- II. To realize a green energy revolution by mobilizing all policy resources for promoting energy conservation, renewable energy utilization and innovative technology dissemination so as to make it possible to realize zero operation of nuclear power plants in the 2030's: and
- III. To assure stable supply of energy by ensuring sufficient electricity supply from fossil fuels, aiming at its more efficient use including the use of heat; and accelerating research and development of next-generation energy technology.

What Should Global Nuclear Community Do?

Shortly after the Accident at TMI NPP in 1979, David Lilienthal, the first Chairman of the US AEC had preached that we should fix nuclear energy, not extirpate it. And global nuclear community has made effort to fix nuclear energy since then as while nuclear energy produced in 1979 about 500TWh or about 8% of world's electricity, in 2011, 30 countries operate 435 reactors that produced 2518TWh or 12.3% of the world's electricity.

In the first 12 months since the accident at the Fukushima Daiichi nuclear power plant, most actors of nuclear energy in the world have acted promptly to draw lessons, and to strengthen nuclear safety. In other words, most has been eager to fix the system.

From my viewpoint, this is the right way to go because though the accident was triggered by a massive force of nature, it was existing weaknesses regarding defense against natural hazards, regulatory oversight, accident management and emergency response that allowed it to unfold as it did and they can be fixed apparently; and second, many believes that nuclear energy offers and will offer many benefits, helping to improve energy security, reduce the impact of volatile fossil fuel prices, mitigate the effects of climate change and make economies more competitive.

Even the newly established strategy in Japan that aims at reducing dependence on nuclear power mentioned that Japan should contribute to strengthening nuclear safety worldwide by sharing with the world its experience and lessons derived from the nuclear accident of last year, and offer its nuclear technologies of the highest standard in safety to those foreign countries which wish to utilize nuclear technologies of our country, taking into account the situation and the will of those countries.

As an old boy, I remember that after TMI accident, A. M. Weinberg who was then the director of the Institute of Energy Analysis at Oak Ridge had argued that such institutional fixes as separation of generation and distribution, professionalization of the nuclear cadre and strengthening of nuclear security should be adopted urgently.

It seems fair to say that his proposal converged after Chernobyl accident to INSAG's three fundamental management principles that were connected with the establishment of a safety culture, the responsibilities of the operating organization, and the provision of regulatory control and verification of safety related activities. They were one of key Principles of the Basic Safety Principles for Nuclear Power Plants issued by the INSAG of the IAEA in 1988.

We can find resonant messages in this year's annual assessment letter to DG Amano of the IAEA from Dr. Meserve, the Chairman of the INSAG of the IAEA. He pointed out

as a part of his observation to stimulate further productive progress in strengthening the safety of nuclear power in response to Fukushima accident followings;

- a) A strong safety culture should be established in every nuclear enterprise.
- b) There should be strong leadership in all the institutions involved in nuclear power that ensures attention to safety, as well as continuing efforts to understand the technology and to improve it.
- c) Every operator should recognize its fundamental responsibility for safety, continuously driving himself for safety excellence, making regular investments to address insights arising from operating experience and evolving knowledge of external events and incorporate advances in safety technology.
- d) The regulator must be competent, independent, and dedicated to the task of ensuring that safety obligations are fulfilled.

As Japanese nuclear energy community remorsefully recognizes, major radioactivity release caused loss of socio-political stability needed for nuclear power. Some people often look upon the safety culture of nuclear energy community suspiciously nowadays. Therefore fixes are required for low probability□high consequences events, to further minimize the potential radioactive releases and environmental and/or public health impact to clarify the suspicion against the safety culture of nuclear community.

I want to say that we should pursue the most profound structural or cultural changes to fix nuclear energy both technically and institutionally through collaboration with diverse disciplines both in and outside of nuclear community and among regional and international community, as it is simply the reality of life that exceptional events enables the most profound structural or cultural changes to make their way into our minds, into our culture, and into everyday implementation.

At the same time, the interest in Fukushima should not interrupt the important obligation for global nuclear community to pay adequate attention to major safety issues associated with the continued operation of nuclear power plants and pursue ongoing programs to assure that plants continue to operate safely. This is also true for the development of innovative nuclear energy technology for future generation.

It would not be fair in this respect if I do not mention that at that post-TMI era, David Lilienthal urged a technical fix, a better-designed reactor that would be immune to meltdown or “meltdown-proof reactor” in short, and A. M. Weinberg promoted the development of reactors that are more forgiving, picking up high temperature gas-cooled reactors and PIUS reactor as leading contenders for ultra-safe reactors.

Should I be disappointed to the fact that no man like Lilienthal or Weinberg has come

out after Fukushima? Probably I should not, because though the appropriateness of the words like inherently safe introduced by the promoters of these concepts had been fiercely debated for some time, After Chernobyl accident, the global nuclear community embraced the concept of passively safe or reactors with passively safe features as a desirable characteristics to be implemented in the advanced nuclear reactors. And the journey triggered by these great figures has been continued and will be continued globally by you, by INPRO and by Generation IV International Forum, or GIF, that was chartered in July 2001 to lead the collaborative efforts of the world's leading nuclear technology nations to develop next generation nuclear energy systems, including VHTGR and GCFR, to meet the world's future energy needs, by reflecting smartly the lessons learned from Fukushima upon their safety and reliability goals.

HTR technology has some promising safety and other characteristics though there are many technical challenges still ahead. My interest is that HTR technology is seriously evaluated internationally and if the apparent promise can be realized in commercial-scale, proceed with international demonstration activities that can lead to possible commercial use.

To close, I will remind you of the challenge before you: to create additional safe, secure and environmentally sound energy sources. I hope you will keep safety, security and low environmental impact foremost in your thoughts on HTRs as you go forward.

I hope you have a productive and enjoyable conference.

Thank you.