Lessons Learned from Fukushima for PSAM Community: Leadership and Responsibility to Assess and Inform Risk for Safety Assurance[1]

Shunsuke Kondo, Dr.
Chairman, Japan Atomic Energy Commission

Good morning, ladies and gentlemen.

It is a great pleasure for me to welcome you to Tokyo PSAM 2013.

Several years after I had organized PSAM 2000 in Osaka, I was asked by the Government to serve Japan Atomic Energy Commission as chairman. Since then I have left the PSAM community and devoted my full time to the deliberation of Japanese nuclear energy policy. Though I expected to finish my third and last term as chairman at the end of last year, I am still working for the Commission. It is another unexpected event to me, though too minor to compare with the Fukushima event.

This morning, I would like to present you my thought on lessons learned from Fukushima for PSAM Community from the viewpoint of leadership and responsibility of the community to assess and inform risk for safety assurance. But before doing so, I should make it clear as a rule that the views I am about to express are my own, and are not the view of the Commission I serve or the view of the Japanese Government.

As already mentioned by our Chair, the Great East-Japan earthquake and the resulting tsunami struck people and facilities, including nuclear power plants, located on the Pacific coast of Japan on March 11, 2011. This caused an unprecedented severe accident at the Fukushima Daiichi nuclear power plant of Tokyo Electric Power Company, TEPCO: a loss of all off-site power and on-site power left the unit 1-4 without any emergency power, and the resultant damage to fuel, reactor, and containment of unit 1-3 caused a release of radioactive materials to the region surrounding the site 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.

Japan has received tremendous outpouring of supports and expressions of solidarity from around the world since the event. Taking this occasion, I would like to convey the Japanese people's sincere gratitude to the global community for its support.

[1] Presented at PSAM Topical Conference in Tokyo in light of Fukushima Daiichi Accident held at Hyatt Regency Tokyo Hotel in Tokyo on April 15, 2013.

At the Fukushima Daiichi, radioactive releases have been virtually suppressed, and reactor cores and spent fuel pools have been maintained at sufficiently low temperature. There are many short-term challenges at the site, however, including those to improve the reliability of cooling system, manage the contaminated water accumulated due to the intrusion of underground water into reactor buildings, reduce the environmental radiation dose and improve work environment.

The Government and TEPCO jointly decided a Roadmap for Decommissioning of TEPCO's Fukushima Daiichi last year, defining three-phase cleanup plan that includes necessary R&D activities, as well as efforts to meet those short-term challenges I just mentioned. The phase 1 of that aims to commence fuel removal from spent fuel pools within two years, the phase 2, to commence fuel debris removal from reactor pressure vessels (RPVs) and containment vessels (CVs) within ten years, and the Phase 3, to complete the cleanup of these units within 30 to 40 years. We hope that they will start the removal of spent fuel from the spent fuel pool (SFP) of unit 4, November this year.

Major R&D projects being promoted at present include those to develop robots for various activities in high radiation environments and remote-handling machines for recovering fuel debris from RPVs and CVs, as well as those to develop robust simulation tools for analyzing severe accidents, focusing on post accidental heat removal, in-vessel core melt progression, in-vessel molten corium retention, molten-core-concrete-interaction and corium stabilization in containment.

As for the off-site consequences, the land contamination due to the accident has spread to the locations at a distance of 250 km or so from the site in a south-east direction, in particular, though highly contaminated areas are limited to 10 km x 30 km rectangular zone extending in a northwest direction from the site. Some 80,000 people are still requested to be out of home and about the same number of people have chosen to leave home by themselves. They are suffering from a psychological agony due to the fear of radiation exposure, unwilling changes in lifestyle, separation of family, disruption of communities etc. We feel deep remorse to the fact that, though anyone has not been hurt by the radiation so far, the accident has caused several hundred deaths due to the worsening of diseases owing to dislocation, including emergency evacuation from hospitals, and/or stress in the life in a shelter after dislocation.

It is unbearable but true that the sales of the products from Fukushima Prefecture have been plummeting due to consumer fear, even though they are not contaminated as the production of agricultural and marine produce are strictly restricted at the place where competent authorities see the danger of contamination.

The Government is supporting the decontamination of people's living environment in the areas where additional annual exposure is less than 20mSv, with a view to reducing the estimated annual exposure of people by 50 % and that of children by 60 % in 2 years. In the areas where additional annual exposure is higher than 20mSv, though excluding areas where

annual doses are higher than 50mSv, the Government is promoting decontamination activities to reduce the annual exposure below 20mSv in two years, forbidding unauthorized entry into such areas. In parallel, the Government is making utmost efforts to assure the operation of Interim Waste Storage Facility in two years that will store about 30 million cubic meter waste generated by such decontamination activities.

However, three out of eleven municipalities in these areas have decided that they would not return to hometown in five years, appealing for the uniform remediation of whole area. One of the biggest issues in this respect is the appropriate measure for and level of decontamination of forests that cover more than 70% of the area.

It should be pointed out here that almost all of these off-site and on-site activities necessarily involve issues related to the management and communication of risk from radiation exposure among people and parties concerned. The Government has established safe levels of radiation exposure below which the situations may be considered practically harmless. However, as the Government has presented them with a health advisory stem from a linear non-threshold model adopted in radiation protection, this caveat has necessarily caused psychological effects on people living in the environment where radiation level is higher than before the accident, even if it is below that in some areas of Europe or USA. There is a huge PSAM issue here, though I will not elaborate it anymore this time.
Well, as you know, various accident investigation teams were organized after the accident, including those organized by the IAEA, the Japanese Government, the Japanese Diet, and various NPOs. They published their judgment on the causes of the disaster and lessons learned from it in succession. Most of them judged that 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 the accident to unfold as it did.

As PSAM community in Japan all the time made it clear that risk information could be effectively used to ascertain that the risk from severe accidents is acceptably low by these measures, the community should answer for the results before us, and appreciate various lessons in these reports, for making a new start.

The verdict issued to the Diet in July 2012 by the National Diet of Japan Fukushima Nuclear Accident Independent Investigation Commission (NAIIC) included, however, a cultural observation that this was a disaster ‘Made in Japan’ and that its fundamental causes are to be found in the ingrained conventions of Japanese culture: our reflexive obedience, our reluctance to question authority, our devotion to ‘sticking with the program’, our groupism and our insularity.

The release of such judgment made it difficult for the Government to allow nuclear power plant operators to restart their plants after introducing emergency measures to cope with the tsunami attack, directed by the regulator at that time, NISA. And the Government decided to

wait the action to be taken by the Nuclear Regulation Authority, NRA, a newly established independent commission body that solely exercises regulatory authority in the field of nuclear safety and security in Japan. This is the reason why only two units among 50 units or so are in operation at present, though the Government is expecting the restart of the operation of idling nuclear power plants, after satisfying new safety regulation rules to be set by the NRA before July as an important power source.

I will leave it at that, as NRA Commissioner Fuketa will present his view in the next session, and I would like to consider the verdict of Dr. Kurokawa who was Chairman of NAIIC a little more, because it has lingered in my heart incessantly.

For us all in the nuclear enterprise, we play a role in the enterprise and we know that our roles require us to act in a responsible manner, recognizing the special responsibility of assuring nuclear safety. My interpretation of Dr. Kurokawa's verdict in this framework is that he asks us to do what we should do at the right time in a right manner, never betraying the nation's right to be safe from nuclear accidents.

Now, let me reflect the past in relation to this verdict. First, the definition of safety.

In 1980s when quality control (QC) circle activities were common in Japan, regulator, when reported by an operator a failure, requested all operators that the recurrence of such failure should be prevented by stringent QC activities. The top management of all operating companies then asked workers to strengthen *Kaizen* activities on the spot. This was the reason why the scram frequency and fail-to-start probability of emergency diesel generators (EDGs) of nuclear power plants in Japan were extraordinary low in the 1980s: proudly spoken story, it was.

This regulatory culture, however, nurtured the recognition that safety was a state without any failure. The trouble of this recognition was it did not motivate regulator to be anxious about risk-information for assuring safety against beyond design basis events, which information can be obtained by making the most of PSAs.

Second, voluntary nature of SAM.

After Chernobyl accident, nuclear safety regulator was wavering on whether its regulation should be expanded to the realm where probability of severe core damage and effectiveness of PCV venting are examined, co-opting risk-informed approach, as PSAM community in Japan proposed to do so in order to push cliff-edges further away. After deliberation for several years, it was agreed in 1990 or so to introduce severe accident managements as a voluntary initiative of operators under the condition that the PCV venting should be delayed as practicably as possible and the inadvertent PCV venting should be prevented reliably. And then, operators developed SAMGs that put emphasis on delayed venting and requested the insertion of rupture disk in the venting line in the case of BWRs.

Looking back on that compromise, I feel that PSAM community should have been more cautious in agreeing on the request for delayed venting, as the delay in venting, though it was delayed at Fukushima due to unavailability of any power sources, invited the accumulation of hydrogen in PCV and the subsequent leakage of it into reactor buildings.

In the discussion of accident management for station blackout (SBO) event, operators carried their position to limit the consideration of accident management procedures to those coping with the station blackout of which duration is less than 8 hours, emphasizing the high reliability of AC power at multi-units sites equipped with both double off-site power transmission lines and double EDGs, and extensive features to cross-tie and share electrical power sources among the units.

Though it was difficult to reject the assertion at that time as it was based on data of excellent performances, PSAM community in Japan should have not missed the opportunity of recognizing the significance of external events to cause prolonged SBO events, when the community informed a flooding event at Blayais NPP in France and a SBO event in Taiwan, for example, and requesting the regulator and operators to review the possibility of a disproportionate increase in consequences from SBO sequences of longer duration caused by external events.

After year 2000 or so, Japanese society experienced large-scale earthquakes, several large-scale blackouts due to strong typhoons (though no loss of off-site power at NPPs, fortunately), and several events of fail-to start of EDG at NPPs owing to the introduction of new designs. Therefore, we could have re-evaluated the validity of these decisions in the occasion of the second round Periodic Safety Review (PSR) activities in which seismic PSA was promised to be included also.

However, the regulator and operators became busy since year 2000 or so in dealing with the discovery and acknowledgment of various data falsification events at NPPs in succession. These events brought regulator to a crisis of trust on operators at the depths of its consciousness. And reflecting this psychological crisis, regulator tended to take a firm stance toward operators, requesting them to prevent error before argue risk and pay deplorably low attention in the second round PSR activities.

It is much to be regretted that this delay in the promotion of external PSAs brought about the failure to openly communicate to tsunami experts the necessity of having information about a tsunami of which return period is 10,000 years or so.

Third, design basis tsunami.

The prediction of tsunami height at Fukushima coast before 1990 was quite modest as shown in the figure published by Professor Rikitake of Earthquake Research Institute of the

University of Tokyo in 1987 that gave the probability for the Pacific coast of Fukushima being hit by a tsunami of which wave height exceeds two meters during a period of 2000 to 2010 as 9 % , and that exceeds 5m, as 0 %.

On experiencing the Hanshin Awaji Earthquake in 1995, the Government established Headquarter for Earthquake Research Promotion (HERP) in the Ministry of Education Culture, Sports, Science and Technology (MEXT). In 2002, the HERP published an evaluation that the occurrence probability of tsunami earthquake of M8.2 along the Japan Trench, including that off Fukushima coast in 10 years was 7%.

Recognizing that the severity of tsunamis due to this earthquake would be significant, Tsunami experts started to estimate it, and, in 2008, an expert at TEPCO made its estimation by assuming a tsunami source similar to that of Meiji-Sanriku-Oki earthquake at off Fukushima coast and obtained a maximum tsunami height of sea level plus 15.7m at the Daiichi site. The top management of TEPCO, however, decided to ask the tsunami expert group of Japan Society of Civil Engineers (JSCE) to review the validity of the assumption, and postponed the consideration of mitigation measures to the flooding to be caused by this height of tsunami.

In 2006, several years before this move, regulator recognized in a revised seismic design evaluation rule that licensed plants had non-zero seismic risk even if they could withstand design basis earthquakes defined in the rule, and requested licensees to confirm the residual risk was sufficiently small. Since then regulator and operators became vigilant in reviewing the contents of the debate held in the academic circles related to earthquake and tsunami as TEPCO did. It was too late, however.

I have more I could say to you, but since I have covered the three points I planned to make, I would like to move to the final part, to tell you what PSAM community in Japan should do in cooperation with regulator and operators, reflecting activities before the accident:

The first, recognize the importance of professional leadership in nuclear organizations that manage potentially hazardous activities to maintain risk to peoples and the environment as low as reasonably achievable without compromise, thereby assuring stakeholder trust. Only leaders can cultivate a questioning attitude and challenging assumptions for safety assurance, make safety-first decisions and deploy appropriate resources based on the consideration of risks associated with the activities.

The second, overcome Japanese insularity, actively participating in international gatherings and dialogues and making best use of operating experiences and information shared in international organizations and forums: receive constructive challenges to Japanese approaches by those with diverse viewpoints and perspectives in the international community and when find new consequences experienced in foreign countries, consider scenarios that

can bring about the same consequences at NPPs in Japan and take action to strengthen defenses against such vulnerabilities.

The third, periodically redefine design basis external events in risk-informed manner, using methodologies and data available that are well vetted and have a strong consensus of experts in relevant fields.

The fourth, ensure the existence of a robust capacity to protect against a beyond-design-basis accident, often in a form of an additional layer of protection to prevent a severe accident regardless of the initiating event. Make sure, however, the objective to do so is to make the risk as low as reasonably achievable through a prudent combination of defense-in-depth and risk insights, but not to strengthen defense-in-depth approach itself.

The fifth, develop new SAM strategies, their implementing guidelines and emergency operating procedures that are consistent with the safety objectives, in collaboration with international community, and completely master them. Decision to deviate from international professional consensus should be made only after rigorous technical reviews.

As Chairman of JAEC, I have insisted in many occasions that as the ultimate responsibility for the safety of a nuclear power plant rests with the operating organization, the operating organization should establish, under strong top management leadership, a strong safety culture to maintain risk to peoples and the environment as low as reasonably achievable, and retain a competent, fit and fully trained staff, thereby assuring stakeholder trust.

At the same time, as there is no credible nuclear industry without a credible regulator, I have hoped, and am sincerely hoping that our regulator has the independence to make regulatory decisions that are open, effective, efficient, realistic, and timely; and the authority to implement them.

Needless to say, regulator’s mission is to enable industries to use and manage nuclear fuels for beneficial purposes, in a manner that protects public health and safety and the environment. Therefore regulator should conduct its business in a transparent and predictable manner, enabling stakeholders to contribute ideas and expertise so that regulatory decisions can be made with the benefit of information from a wide range of stakeholders. We can say in this context that there is no credible nuclear regulator without credible nuclear industry.

In conclusion, PSAM community should recognize that risk information its supplies is vital for regulators and operators to fulfill their mission of assuring safety of a system in a responsible manner. Key questions PSAM experts should answer to prepare risk information are “What can happen in and to the system?” “How likely is it to happen?” “What are its consequences, given that it occurs?” and “What an impact does a change in the system have on these answers? As it is not possible to test the system in all conditions to answer these questions, PSAM experts rely on models, both continuous and discrete event ones that have

been supported by test data and expert judgment. PASM experts should present their answer in the form of risk curves including uncertainty in frequencies, comprehensively treating model and parametric uncertainties and executing sensible sensitivity studies. You should ascertain that your answer would be useful for decision-makers to make rational decisions, including that on changes, in the risk management of the system for the benefit of human society. [2]

Finally, I would like to thank everyone involved with putting on this meeting. It is only through the hard work of a large number of dedicated individuals and the support of their organizations that meeting like this can be successful. Forums like this provide a unique opportunity to realize interactions I recommended a few minutes ago. I sincerely hope you will enjoy such interaction and stay in Tokyo.

Thank you for your kind attention.

[2] This paragraph was revised after presentation was made.