Where Japan is and where Japan will go: Update of the Fukushima Accident and Post-Fukushima Nuclear Energy Policy in Japan[1]

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The Great East-Japan Earthquake and the resulting tsunamis struck the Fukushima Daiichi Nuclear Power Plant on March 11, this year, and caused a serious nuclear accident. The fact that this accident has raised concerns around the world about the safety of nuclear power generation is a matter we take with the utmost seriousness and remorse.

At the same time, I would like to express Japan's sincere gratitude to you all, as Japan has received support and expressions of solidarity from around the world in the face of this hardship. Japan profoundly felt the deepness of the bond or kizuna in Japanese, which we have with countries around the world.

The reconfirmation of importance or preciousness of the bond among peoples and between the sufferers and those who live outside of the stricken area in particular has become very popular in Japan after the tragedy in March. They talk each other and through conversation and joint activities, they find meaning and joy, and even discover a greater wisdom that reveals their path forward. Someone comment that crises reawaken our deep species memory of two fundamental facts about human life. First we humans want to talk together about things that matters to us and such talk gives us satisfaction and meaning to life. Second, as we talk together, we are able to access a greater wisdom that is found only in the collective.

I am sure that this ICONE 19 in Osaka will be an excellent occasion for us to talk each other and reconfirm our bond or kizuna among us and cultivate the courage to talk and work together with peoples in many parts of the world to solve problems of our society utilizing nuclear science and technology. In the case of Japan, the talk may not be so easy for you as

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more than 70% of the public support the abolition of nuclear power. We should pursue the kizuna with the public, however, as we can be wise only together.

In the following, I would give you my thought on the accident progression, root causes of the accident, onsite and offsite situation at Fukushima and finally post-Fukushima nuclear energy policy in Japan under deliberation.

ACCIDENT PROGRESSION

When the earthquake hit the plant, units 1 to 3 were in operation and unit 4 was in a maintenance mode. Sensing the earthquake, the operating units were shutdown automatically and as external power sources were interrupted due to the earthquake, emergency diesel generators of all units and shutdown cooling systems supported by them were started successfully.

In 40 minutes or so, the site was flooded by huge tsunamis to the level of 4 m height and the emergency diesel generators and sea water pumps became inoperable as they were not prepared for such flooding, and the shutdown cooling system and the path to the ultimate heat sink became unavailable.

Although the alternative core cooling systems started operation and worked for some time, their capability was eventually lost due to the depletion of DC batteries. Operators were requested in such occasion to find ways to depressurize the Reactor Pressure Vessel and start the fire pump to inject water into the core and vent the Containment Vessel to assist the core cooling. Operators could not do so timely at this time, however, presumably due to insufficient preparation and the devastation of the site due to violent tsunamis.

Consequently the core melting started, the hydrogen that was generated due to zirconium-water reaction in the core leaked out to the containment vessel and then to the reactor building, as the pressure and temperature of the containment vessel became high enough for damaging the penetration seals, which provided leak paths for hydrogen. The explosion of hydrogen thus accumulated in the reactor buildings destroyed the upper parts of reactor buildings of units 1 and 3.

The fission products leaked out in the containment vessels were released into the environment depending on the severity of such damage of containment vessels, though some of them were

trapped in the water of suppression pool in the course of wet-well venting operation. Owing to day-long releases of significant amount of radioactive materials, a large area around the site was contaminated.

ROOT CAUSE OF THE ACCIDENT

The direct cause of the accident was obviously the losses of emergency diesel generators, power centers, and ultimate heat sink due to the flooding of the site by tsunami, of which height was significantly higher than the design basis.

Why had all the units essentially no mitigating features against such flooding events? The reason was, from my viewpoint, that the operators and regulators have lacked keen attention to the importance of preventing land contamination. Living in narrow and high population density area, Japanese nuclear safety people should have been keen to the prevention of soil contamination due to large releases, after witnessing the tragedy caused by the Chernobyl accident. The regulators and operators were shy with PRA and did not promote the IPEEE, however, and lost the opportunity to identify the need for severe accident mitigation features that should prevent large releases of iodine and cesium.

To be specific, they failed to let the experts in external hazards and tsunami in particular, know the necessity of having information about a tsunami that has a frequency of exceedance of less than 1 in 10,000 years. Before 2000 or so the experts of tsunami have been interested in finding the historical maximum tsunami height at a given site within limited resources available to them. The nuclear safety people have utilized it as a design basis, however, with little attention to such situation.

In addition, nuclear regulator failed to request plant designers/operators to satisfy the internationally recognized need for defense-in-depth features that would prevent a disproportionate increase in radiological consequences from an appropriate range of events which are more severe than the design basis event. This failure caused the absence of essentially no mitigation features against the flooding due to tsunamis in the units.

Furthermore Japanese nuclear society lacked clear lines of responsibility and the peer reviewed safety policy statement that declare the objectives of and the commitment to nuclear safety consistent with global standards. Accordingly the regulator and operators have tended to limit their attention to issues within deterministically-set design basis, and they have not

been active in periodic safety review based on probabilistic analysis, questioning attitude, the learning from experience, and a commitment to excellence.

Thinking over such situation that has come to light, the Government has decided in August to establish "The Nuclear Safety and Security Agency" as an external agency of the Ministry of Environment around April of next year, by separating off the Nuclear and Industrial Safety Agency (NISA) from the Ministry of Economy, Trade and Industry, with a view to centralizing the regulatory function and ensuring a thorough safety culture.

THE ON-SITE MANAGEMENT

In April, TEPCO published a roadmap towards restoration from the accident that was composed of Step 1, Step 2 and mid-term measures. The target of Step 1 that was the steady decline of radiation dose at the site was completed by the establishment of systems to inject circulating water for RPV cooling on July 19, 2011. Currently, the target of Step 2 to put the release of radioactive material under control and significantly hold down the radiation dose around the site are being pursued by lowering the temperature of RPV bottom below 100 degree Centigrade.

The treatment of accumulated water is a big issue for increasing the water available for RPV cooling and reducing the total amount of water in the reactor buildings. Currently various works are being done to improve the performance and the reliability of the system for decontaminating and then desalinating the highly contaminated water. We hope that the step 2 will be completed before the end of the year.

After the completion of Step 2, a cleanup program at Fukushima should be started as it will not be allowed to turn the damaged plants into nuclear waste disposal facility. The objectives of the cleanup program are, to maintain the reactors in a safe condition, remove the spent fuel from spent fuel pools, collect and dispose the radioactive materials resultant from the accident and disassembling the reactors, identify the location and configuration of the damaged fuel cores and remove and dispose them. The Atomic Energy Commission has established a committee to review the possible scenarios for the promotion of the cleanup program and the committee is preparing a preliminary report on such scenarios and a list of R&D activities useful for identifying and removing the core debris from RPVs and CVs.

THE OFFSITE MANAGEMENT

As the area around the site was contaminated due to the large release of radioactive materials, the Government has been pursuing to limit the radiation exposure of a people by means of a) restriction of inhabiting in the area where expected annual additional dose is larger than 20 mSv, b) strict shipping control for agricultural products, animal products and marine products through comprehensive radiological surveys and c) step-by-step decontamination of the land.

The government strategy for decontamination is to reduce the area where estimated annual additional exposure is larger than 20 mSv and residents have been evacuated already through step by step decontamination activities and to reduce the annual additional exposure to 1 mSv by steady decontamination activities in inhabitation area where it is currently below 20 mSv but above 1 mSv.

In the inhabitation area, municipal governments are leading the execution of such decontamination activities. Based on the decontamination guidelines established by asking experts for advice, they are promoting regional decontamination in highly contaminated areas and localized decontamination in relatively low contamination areas, identifying hot spots such as those locations where sludge in the drains or gutters has collected. Special attention has been paid for the decontamination of schools so as to reduce the exposure of children as low as practicable. As a result, the effective annual additional exposure at most schools in this area has been reduced to 1 mSv before resuming the class.

As for the evacuated area, the Government is promoting a set of large scale demonstration decontamination projects at present to test the effectiveness of various decontamination approaches so as to prepare guides for executing safe, effective and efficient decontamination activities. Utilizing such guides, the Government will plan and promote a full-scale decontamination activity before the end of the year so that more than 100, 000 displaced persons can return home as soon as possible.

It is very important for the Government and municipalities suffered to promote thorough radiation monitoring, comprehensive safety assessment and stakeholders' involvement in the planning and execution of such remediation activities. A big challenge at this occasion is to find places for facility to temporarily store contaminated soil and waste collected by such decontamination activities. Promising that a large-scale interim storage facility that will accept both soil and waste will be available in a few years, the Government hopes that each municipality or community will determine the place for such facility by themselves.

POST-FUKUSHIMA NUCLEAR ENERGY POLICY

Before March 11, Japan was a major energy consuming country in the world, as she was 5th largest energy consumer, 3rd oil importer and 1st LNG importer. Fossil fuels were dominant in primary energy mix of Japan and their supply mostly depended on imports: 90% of crude oil supply was imported from the Middle East. The energy self-sufficiency was only 4% and if nuclear is categorized as domestic energy, it was about 15% in 2009. Therefore, the volatility in global energy prices, the need for secure supply of fossil fuel even though energy demand is growing in Asia and the reduction of greenhouse gas emission had been unfailing issues for Japan and nuclear energy had been expected to contribute to resolve these issues.

After March 11th, the top priority issue in energy sector in Japan was, apart from the stabilization of Fukushima Daiichi, how to cope with the shortage of electric power supply, since 10 fossil fuel power plants and 9 nuclear power plants was suddenly lost by the earthquake and tsunami. The electric utilities have done their best to assure power supply capacity by restoring standstill power plants and securing fossil fuel for such plants. The Government has asked the industry and the public to enhance power saving and efficiency improvement.

Under such conditions, the short-term goal of nuclear energy policy was to make best use of existing nuclear power plants, making sure the safety of them against the flooding by tsunami and restoring the public trust in nuclear safety. In reality, however, the number of nuclear power plant in operation has reduced from 26 (excluding 9 units affected: 16 units were under periodic inspection.) in March to 10 in October due to the difficulty in obtaining the consent of central and local governments to restart the plants that completed the compulsory periodic inspection. Why are we in such situation?

Just after the accident at Fukushima, the NISA, nuclear safety regulator of Japan asked every nuclear power operator to implement emergency safety measure for preventing the occurrence of severe core damage even when they are hit by beyond design basis tsunami such as preparation of fire engine, power supply cars, and emergency drill to utilize them and establish a plan to further improve the safety of their plants against external hazards such as the improvement of water tightness of safety significant SSCs. On May 6, the NISA confirmed that as all NPP operators had properly implemented the measure, all the nuclear power plants that had passed the periodic inspection were eligible to resume operation.

However, Prime Minister expressed his view that the NPP should pass a test similar to European “stress test” before restart. The NISA therefore deliberated under the guidance of the Nuclear Safety Commission the content of the test called “comprehensive safety assessment (CSA), which should clarify the margin or distance between design basis event and the threshold of events beyond which severe accident will be inevitable. Currently nuclear operators are submitting the result of the preliminary CSA to restart their plants and all units are to submit the results of the secondary CSA in due time. We still have to do hard work for restoring the public trust in nuclear safety before being allowed to restart those plants.

As for mid- and long-term energy policies, the Energy and Environment Council of the government, that is a ministerial committee in the cabinet, has initiated the work to formulate them based on the deep reflection on the March 11 event at Fukushima. They set the goals of energy policy as stability of supply, economy, friendliness to environment and safety & security or ANSIN in Japanese that means peace of mind.

The Council already decided to start the discussion about the best use of fossil energy, renewable energy, nuclear energy and efficient use of energy for the attainment of these goals from the beginning of 2012. Considering that more than 70% of the public are in favor of abolishing the nuclear power plants, the discussion will be focused on the practicality of eventual or early graduation from the use of nuclear energy and instead, drastic increase in the share of renewable energy for attaining these goals in Japan, which is an island nation making a living by foreign trading.

It is imperative for nuclear energy community to make every effort to explore the ways to make our nuclear power system acceptable to the public in a rage by improving the merit and reduce the demerit as a way to attain the specified energy policy goals under possible new condition for competition.

At the same time we should deliberate how the fuel cycle system should be for a given future nuclear energy utilization scenario and how we can continue to promote bilateral, multilateral and international cooperation and joint activities for R& D of nuclear safety, security, safeguards, nuclear fusion energy and so on, as a responsible country.

Needless to say, it is a prerequisite for us even in this or more severe situation to assure the safety, security and proliferation resistance of nuclear energy supply system (including the

fuel cycle activities committed) by establishing and maintaining the excellence in operation and regulation from the view point of global standards and building human resource that is enthusiastic about these tasks.

CONCLUSIONS

The accident at Fukushima Daiichi Nuclear Power Plant of TEPCO on March 11, 2011 was caused by the unprepared attack of tsunami and contaminated a wide area around the plant.

The root cause of this accident seems to be the weak recognition of the paramount importance of three fundamental nuclear safety management principles; the establishment of a safety culture, the responsibilities of the operating organization, and the provision of regulatory control and verification of safety related activities.

To recover the life of suffered people and society by way of the on-site and off-site activities should be a prime task for nuclear community though it will cost a huge sum of resources and extend over a long period of time, as many people has been traumatized by the relocation, the breakdown in social contacts, fear and anxiety about what health effects might result.

The deliberation of future energy policy has been started, searching the possibility of reducing the dependence on nuclear power in future. Nuclear energy community should make every effort to explore the ways to make nuclear power system acceptable to the public in a rage based on deep reflection of the occurrence and results of the severe accident at Fukushima Daiichi.