VI. Situation regarding efforts to address lessons learned (28 items)

Japan is making its greatest possible efforts to address the 28 “lessons learned” indicated in the June report. The state of progress among these items is not uniform, with some items already having been fully implemented, others now in the process of being implemented, and still others that are to be newly planned in the future. Japan will prevent the recurrence of such an accident as this by addressing each item steadily and thoroughly based on the idea of “defense-in-depth,” which is the most important basic principle in securing nuclear safety. In addition, while the NISA has given directions of immediate emergency measures to operators since March 30 based on the findings about this accident as of the time point, it is contemplating that the contents which are supposed to respond to each of the lessons need to be further reviewed based on extensive knowledge in Japan and overseas from now on and be improved and reinforced.

Particularly, Japan aims to establish a new safety regulatory organization and system by establishing Nuclear Safety and Security Agency (tentative name) by around next April. As efforts to establish reinforced safety regulation under the new system and the concrete responses to these “lessons learned” are closely related, they are to be promoted through appropriate coordination.

Lessons in Category 1

Prevention of severe accidents

(1) Strengthen measures against earthquakes and tsunamis

The tsunami damage that caused the recent nuclear accident was brought about because of inadequate preparedness against large tsunamis, including the failure to adequately envisage the frequency of occurrence and the height of tsunamis. This has led preventive measures against tsunamis at nuclear power stations becoming one of the top priorities.

In terms of measures against earthquakes and tsunamis, as noted in this report, those mechanisms, etc. that caused the Tohoku District-Off the Pacific Ocean Earthquake and resulting tsunamis, triggering the Fukushima nuclear accident, are being studied in detail by such research institutes as the Japan Nuclear Energy Safety Organization (JNES). Such recent findings are expected to serve as a basis for future preventive measures against earthquakes and tsunamis at nuclear facilities.

In particular, measures against tsunamis are at the top of the agenda for Japan and on June 26, 2011 the Central Disaster Management Council set out a basic policy for future preventive measures against tsunamis, including those that assume the largest possible tsunami and the most frequent tsunami. The NSC has undertaken and is pursuing discussions on review of the NSC Regulatory Guides regarding earthquake and tsunami considering the Council's suggestions and the progress of discussions by Japan Society of Civil Engineers etc.

In this context, the Nuclear and Industrial Safety Agency (NISA) has undertaken discussions in terms of "defense-in-depth," of a design basis that assumes adequate frequency of occurrence, with an adequate recurrence period taken into consideration, and height of tsunami; and of criteria for safety design of structures that allows for the impact force of tsunami waves, etc.

(2) Ensure power supplies

One of the significant factors of the accident was failure to ensure necessary power supplies. Therefore NISA has requested nuclear plant operators to ensure concrete power supplies, and the operators have already implemented the deployment of power-supply vehicles which supply the requisite power for emergency reactor cooling, the securing of emergency diesel generator capacity for a state of cold shutdown (sharing emergency power supplies with other units), countermeasures against flooding for important equipment within a reactor building (sealing of areas of penetration and doors, etc.), and assessments of the degree of reliability of power grid.

Currently, nuclear plant operators are also taking measures such as the installation of large-sized air-cooled emergency diesel generators and air-cooled emergency gas turbine generators, measures to improve the reliability of power supply based on the outcome of the assessment of the reliability of the electrical systems (transmission line enforcement, etc.), tsunami protection measures for the switchyard, etc., countermeasures against collapses of transmission line towers and seismic reinforcement of switchyard equipment. In addition, the enhancement of battery capacity and seismic reinforcement of fuel tanks for emergency diesel have been planned as future efforts.

(3) Ensure reliable cooling function of reactors and PCVs

Since the loss of the cooling functions of the reactors and the PCV led to aggravation of the accident, as specific countermeasures, the plant operators, under instructions from NISA, deployed alternative/external water injection devices (pump tucks, fire engines, hoses, coupling parts, etc), ensured the capacity of freshwater tanks, and arranged feedwater lines that take water from the sea.

Currently, in order to bring the reactors to a state of cold shutdown as early as possible, the operators are procuring seawater cooling pumps, spare parts for motors, and temporary pumps which facilitate early restoration, as well as installing large-sized air-cooled emergency generators to drive seawater cooling systems. Also, as future efforts, they plan to make seismic reinforcements of large-sized freshwater tanks and other related efforts.

(4) Ensure reliable cooling functions of spent fuel pools

In the accident, the loss of power supplies led to failure of the cooling for the spent fuel pool. The operators, under instructions from NISA, in order to maintain cooling of the spent fuel pool even when power supplies had been lost, deployed alternative/external cooling water injection devices for the spent fuel pools (pump tucks, fire engines, hoses, coupling parts, etc.), ensured the capacity of freshwater tanks, and arranged feedwater lines that take water from the sea.

Beyond this, they plan to undertake seismic reinforcement of the cooling piping system for the spent fuel pool, etc. as future efforts.

(5) Thorough accident management (AM) measures

Since AM measures were found to be insufficient during the current accident, hereafter efforts shall be implemented to ensure thorough enhancement of AM measures.

The NSC has resumed discussions on upgrading the AM measures which had been discontinued due to the accident of this time. Also, NISA developed an operational safety program and expanded/clarified the interpretation of technical standards regarding emergency response procedures and so on which will enable the stable cooling of the reactor even should all AC power supply and all seawater cooling functions be lost. Hereafter, it plans to implement the work to seek to legislate AM measures based on the result of the examination undertaken by the NSC.

In addition, it plans to adopt a probabilistic safety assessment approach as it develops more effective AM measures.

(6) Responses to multi-unit site issues

The accident revealed issues in the area of responses to accidents at sites having multiple units, since the accidents occurred simultaneously in multiple reactors, and development of the accident at one reactor affected the emergency responses to the accident in neighboring reactors. Thus the plant operators, under instructions from NISA, developed for each reactor independent responsibility systems, systems for accident responses, and procedures.

Hereafter, the measure to ensure the engineering independence of each reactor at sites having more than one reactor are planned to be considered.

(7) Consideration of NPS arrangement in basic design

During the accident, response to the accident became difficult since the spent fuel storage pools were located at a higher part of the reactor building. In addition, situations arose in which contaminated water from the reactor buildings reached the turbine buildings, meaning that the spread of contaminated water to other buildings was not prevented. Accordingly, sufficient consideration of an adequate layout for the facilities and buildings of NPSs is required at the stage of basic design for new construction, and the embodiment of those considerations is being planned.

(8) Ensuring the water tightness of essential equipment and facilities

During the accident, a substantial amount of essential equipment and facilities were flooded due to the tsunamis, impeding the ability to ensure power supply and cooling water. Thus, ensuring the water tightness of essential equipment and facilities even in the case of a massive tsunami is important. The operators, under instructions from NISA, took countermeasures against flood damage to important equipment within the reactor buildings (sealing of penetrations, doors, etc). Currently, the operators are reinforcing the water tightness of the reactor buildings and installing watertight doors and so on.

Lesssons in Category 2

Countermeasures against severe accidents

(9) Enhancement of measures to prevent hydrogen explosions

During this accident, the accident was aggravated by hydrogen explosions. Therefore, enhancement of countermeasures against hydrogen explosions, including measures pertaining to reactor buildings, became an important issue.

For boiling water reactors (BWRs), the operators, under instructions from NISA, as countermeasures against hydrogen leakage into reactor buildings will install exhaust ports by making a hole in the roof of each reactor building, and conducts arrangements for implementing this work. Also, as mid- to long-term efforts, the installation of hydrogen vents atop reactor building and of hydrogen detectors in reactor buildings are planned.

For pressurized water reactors (PWRs), the operators, under instructions from NISA, confirmed that hydrogen leaked from a PCV into the annulus is reliably vented to the outside of the annulus by the already installed annulus exhaust system. Also, as mid- to long-term efforts into the future, the installation of equipment to decrease concentration of hydrogen in PCVs, including passive catalytic hydrogen recombiners requiring no power supply, is planned. For reactors with ice condenser type PCVs, it has been confirmed that hydrogen leaked into the PCV is reliably treated by the already installed igniters (hydrogen burning equipment). This includes confirmation of the operability of the igniter using a power supply from power-supply vehicles, should all AC power supplies be lost.

(10) Enhancement of the containment venting systems

In this accident, problems arose in the operability of the containment venting system for severe accident as well as its functioning in the removal of radioactive materials.

Under instructions from NISA, as initial measures, the plant operators installed standby accumulators for air valves, which enable operation of valves in vent lines even should AC power supplies be lost, as well as transportable compressors and other such equipment.

Also, in addition to these initial measures, further efforts in future will be made towards enhancing the PCV vent system by extensively considering technical expertise in Japan and overseas, including enhancement for the radioactive material removal function.

(11) Improvements to the accident response environment

At the time of this accident, as the radiation dose in the main control room increased, the situations that the operating staffs were unable to enter the main room temporarily, etc. posed problems for accident response activities in various situations.

Under instructions from NISA, the plant operators have taken steps to ensure on-site communication tools (a power supply for on-site PHS communication facilities, transceivers) a portable lighting system, and means of securing a work environment in

the main control room (a power supply by power-supply vehicles to the ventilation and air conditioning systems), etc.

Also, along with implementing measures such as the transfer of on-site PHS facilities, etc. to higher ground, there are now plans to enhance functions at emergency stations, seismically reinforce office buildings, and so on.

(12) Enhancement of the radiation exposure management system at the time of the accident

In this accident, adequate radiation management became difficult as the radiation dose increased within the NPS due to the release of radioactive materials. Given this background, under instructions from NISA, the operators deployed the protective clothing against high radiation doses necessary for the early stages of an accident at NPSs, arranged mutual cooperation among operators for protective clothing against high radiation doses, personal dosimeters, full-face masks, and other such equipment, developed a system by which radiation control staff could focus on important operations to ensure radiation control in emergencies, improved employee training for radiation control in emergencies, and other such improvements.

(13) Enhancement of training for responding to severe accidents

Effective training for responding to severe accidents has not sufficiently implemented in the past. Moreover, in this accident, had training been implemented before the accident, more adequate actions could have been conducted.

Therefore, under instructions from NISA, in April the plant operators conducted emergency response training at NPSs witnessed by government staff to prepare workers for a loss of all AC power supplies, a loss of seawater cooling functions, tsunami strikes and other such emergent situations.

The government will also request the operators to implement nuclear emergency drills to prepare for the occurrence of severe accidents and their prolongation and escalation caused by primary coolant pipe breaks or other such accidents. Additionally, the government is also examining hands-on nuclear disaster prevention drills which simulate severe accidents that coincide with complex disasters as happened in this accident, and plans to engage in support and cooperation such as necessary advice for the drills performed by local authorities.

(14) Enhancement of instrumentation for reactors and PCVs

In this accident, under the severe accident conditions, the instrumentation of the reactors and PCVs failed to function sufficiently, and it was difficult to adequately obtain information on the water levels in the reactors and other information that was necessary for responding to the accident.

Consequently plans are being made for the development and preparation of instrumentation of reactors, PCVs, spent fuel pools, etc. to enable adequate functioning even under severe accident conditions.

(15) Central control of emergency supplies and setting up of rescue teams

Shortly after the accident, under the damage conditions caused by the earthquake and tsunamis, the securing of emergency response equipment and the mobilization of rescue teams to support accident control activities were not performed sufficiently.

Therefore, under instructions from NISA, the plant operators have been engaged in the establishment and management of emergency response equipment (power-supply vehicles, pump trucks) and the creation of implementation forces to operate such equipment. They are also arranging and then preparing for common use among plant operators of masks, protective clothing, and the like to provide protection during work with heavy machinery to dispose of rubble or work having high radiation doses, and otherwise developing systems for mutual cooperation.

Plans are also being made for the preparation of emergency response equipment, including robots, unmanned helicopter drones, heavy machinery, decontamination equipment and accident progression prediction systems, as well as for the enhancement of capacity building through training of Self-Defense Forces, police, firefighters, the Japan Coast Guard, and other key personnel.

Additionally, under the new safety regulatory organization, the system for responding to crisis management will be enhanced through the establishment of staff specializing in responding to emergency conditions.

Lessons in Category 3

Responses to nuclear emergencies

(16) Response to a combined situation of massive natural disaster and nuclear emergency

This time a massive natural disaster was followed by a nuclear accident to produce a complex disaster. Also, the prolonged nuclear accident caused difficulties in securing

means of communication and of procurement as well as in the mobilization of the full range of support personnel for the accident and disaster response.

Therefore, off-site centers have been reinforced by deploying satellite phones, emergency power supplies and reserves of goods. Deploying alternative materials and equipment is also planned so that alternative facilities may be utilized immediately even if the situation necessitates relocating the function of an off-site center. Moreover, regarding the response to a complex disaster, a review of the full readiness and chain-of-command structure will be made across ministries and agencies.

(17) Reinforcement of environmental monitoring

During the initial stages of this accident, appropriate environmental monitoring became impossible due to damage to local authorities' monitoring equipment and facilities caused by the earthquake and tsunami.

The "Monitoring Coordination Meeting" has therefore been established within the government for the coordination of, and smooth implementation of, environmental monitoring conducted by ministries and agencies, local authorities and TEPCO. The "Comprehensive Monitoring Plan" was developed as an initiative for the immediate future. Based on this Plan, related organizations are engaged in partnership in monitoring by aircraft, monitoring of sea areas and radiation monitoring with a view to facilitating the lifting of restrictions on Emergency Evacuation-Prepared Areas, among other endeavors, and preparation of cumulative dose estimation maps and maps indicating the distribution of radiation doses, etc. Also, in an emergency, the government will take responsibility for establishing the system of performing environmental monitoring surely and deliberately, and it will have the new safety regulation organization play a commanding role in environmental monitoring.

(18) Clarification of the allotment of roles between central and local organizations

In the initial stages of the accident, communication and cooperation between the central and local governments as well as between various relevant organizations were not achieved to a sufficient degree, due to the difficulty in securing means of communication and also due to the fact that the roles and responsibilities of each side were not always clearly defined.

Therefore in responding to the current accident, local bases to respond to the accident were established by utilizing J Village and the Onahama Coal Center. Central organizations to coordinate response activities were also established, including the

Government-TEPCO Integrated Response Office, the sufferers' livelihood support team and the Office of Response to Radioactive Materials Contamination.

Hereafter, roles and responsibilities of relevant organizations including the GNER HQ will be reviewed to enable prompt and appropriate responses, and measures will be taken to amend Acts and revise manuals when necessary. Also, communication systems, including communication tools and channels, will be reviewed in order to enable the delivery of information quickly and with certainty. Furthermore, as for the video conference system used at the time of nuclear disaster, it is planned to interconnect relevant governmental organizations, all electric power companies and NPSs to ensure quick and adequate instruction and information collection in emergency situations.

(19) Enhancement of communication regarding the accident

Especially immediately after this accident, actions were not sufficiently taken to provide local residents with information or easily-understood explanations about radiation, radioactive materials, or information on future outlooks on risk factors.

Therefore, a "one-stop counseling service"was established to provide consultation services to local residents, especially residents of Fukushima Prefecture, on the situation regarding the accident, radiation's impact on health and other matters. Also, as for the disclosure of information to the citizens, jointly-held regular press conferences and other opportunities have been conducted by relevant organizations such as NISA and the NSC.

Based on the disclosure of information regarding the Fukushima NPS accident and on the experience of communicating in the contexts of various domestic and foreign disasters as well, it is planned to examine ways of disclosing and providing information during significant NPS accidents, to develop a basic manual, and to provide education and training on that basis to relevant organizations regarding information disclosure and provision.

(20) Enhancement of responses to assistance from other countries and communication to the international community

After the accident, the government could not promptly respond to offers of assistance from other countries around the world (e.g., offers to supply equipment). Initially information was not always fully shared in advance especially with neighboring countries.

In light of this, in order to immediately notify neighboring countries in the case of an accident, contact points for each neighboring country have been specified. The list of

contact points will be updated, as appropriate, to ensure the quick and accurate provision of information to the international community.

The system for international responses to an accident will be improved as part of implementing the IAEA Action Plan on Nuclear Safety, including the development of lists of equipment effective for accident responses and methods for international information sharing, including through international notifications. Japan will actively contribute to such international efforts.

(21) Accurate understanding and prediction of the effect of released radioactive materials

In this accident, the use of the System for Prediction of Environmental Emergency Dose Information (SPEEDI) and disclosure of its calculation results, etc. were not properly conducted.

Against this background, since April the government has been disclosing the calculation results of SPEEDI. Since June, the government has also been using SPEEDI for environmental impact assessment after opening the reactor buildings of the Fukushima Dai-ichi NPS as well as for estimating external radiation exposure to residents to supplement the monitoring data that were not sufficiently collected during the early stages of the accident. The results of such evaluations have been disclosed without delay.

In future, the new safety regulation organization will serve as a control center for environmental monitoring, including the operation of SPEEDI, and more effective ways of utilizing SPEEDI will be considered in that context.

(22) Clear definition of the criteria for wide-area evacuations and radiological protection standards in nuclear emergencies

Criteria for specific nuclear emergency response actions, etc. were not well prepared before the accident, especially for wide-area evacuation and radiological protection associated with a prolonged accident.

Moreover, relevant organizations will promote examination the standard of radiological protection, etc. on the basis of this accident. Moreover, the NSC started reviewing “The Regulatory Guide for Emergency Preparedness of Nuclear Facilities”, including the definition of the Emergency Planning Zone (EPZ).

Japan will make efforts to reflect the Fukushima experience of accident responses within the review of the standards of International Commission on Radiological

Protection (ICRP) and the IAEA standards for nuclear emergency preparedness and radiological protection.

Lessons in Category 4

Enhancement of safety infrastructure

(23) Enhancement of safety regulatory and administrative systems

Due to the unification of administrative organizations over the utilization and regulation of nuclear power and the non-centralized administrative organizations for ensuring nuclear safety, it was unclear until recently which organization has primary responsibility for disaster prevention and the protection of public safety. Reviews of such bodies and the enhancement of nuclear regulatory bodies need to be done promptly.

Therefore, the Japanese Government decided on the "Basic Concept of Structural Reform of Nuclear Safety Regulations" at the Cabinet Meeting of August 15 this year and decided on the launch of a new safety regulatory body. Specifically, considering international discussions in the past, and on the basis of the principle of "separating regulation from utilization," the nuclear safety regulatory divisions of NISA will be separated from the Ministry of Economy, Trade and Industry, with "Nuclear Safety and Security Agency (tentative name)" aimed to be established by April 2012 as an external agency of the Ministry of Environment by integrating into it the functions of the NSC. For this purpose, the capabilities of this regulatory body will be enhanced by centralizing nuclear safety regulatory activities, a dedicated risk management division will be established to enable this Nuclear Safety and Security Agency to take quick initial responses, and efforts will be made to recruit highly qualified personnel from both the public and private sectors to adequately execute the regulatory activities. In addition, a "Task Force for the Reform of Nuclear Safety Regulations and Organizations." was established on August 26 for the preparation of the bill necessary to establish the new organization.

(24) Establishment and reinforcement of legal frameworks, standards and guidelines

The accident raised a wide range of issues regarding the establishment of legal frameworks and related standards and guidelines regarding nuclear safety and nuclear emergency preparedness. There will also be many issues that should be reflected within the IAEA's standards and guidelines in light of the experiences of the accident.

Reflecting this, a revision of the legal framework, standards, and so on with regard to nuclear safety and nuclear emergency preparedness is scheduled, based on knowledge learned from the accident, including the introduction of a new safety regulatory framework (e.g., backfitting), the enhancement of safety standards and the streamlining of complicated nuclear safety regulatory and legislative systems. Furthermore, a detailed evaluation of the basic designs of nuclear reactors, etc. and review of the relationship between reactor types and the causes of the accident will be carried out, and the safety and reliability of existing reactors will be evaluated on the basis of technological progress in nuclear reactor design and comparisons with the latest technologies.

Furthermore, the Japanese Government will actively provide its experience and knowledge from the accident to contribute to a review of the IAEA's standards and guidelines.

(25) Human resources for nuclear safety and nuclear emergency preparedness and responses

The accident re-emphasized the vital importance of developing human resources in the fields of nuclear safety and nuclear emergency preparedness in order to respond to an accident similar to the Fukushima accident.

Therefore, the new safety regulatory body will have among its basic policies securing personnel who are highly qualified with regard to regulatory matters through reinforced training. This body will also deliberate the establishment of an International Nuclear Safety Training Institute (tentative name), as a research institute that will seek to improve the quality of its human resources and engage in international cooperation. Also, through further promoting activities of "Japan Nuclear Human Resource Development Network" established in cooperation among industry-academic-government related organizations, etc., this body will work to advance the reinforcement of human resources development in such fields such as nuclear safety, nuclear emergency preparedness, risk management and radiation medicine.

(26) Ensuring the independence and diversity of safety systems

With regards to ensuring the reliability of safety systems, insufficient consideration was given to approaches that would avoid multiple malfunctions all having a common cause in having been triggered by the earthquake and tsunamis, etc. Furthermore, independence and diversity were not achieved to a sufficient degree.

In response to this situation, there are plans to respond appropriately to multiple malfunctions having a common cause, to attain further enhancement of the reliability of safety functions such as in ensuring the independence and diversity of types, storing locations, and other aspects of emergency power generators and seawater cooling systems and to strengthen ensuring the independence and diversity of safety systems.

(27) Effective use of probabilistic safety assessment (PSA) in risk management

PSA has not always been effectively utilized in the overall reviewing risk reduction efforts at nuclear power facilities.

Therefore, NISA and the Japan Nuclear Energy Safety Organization (JNES) are now engaged in deliberations of revisions to legislation and standards, etc., on the premise of the utilization of PSA. Also, regarding the Tsunami PSA, the Japan Atomic Energy Society is preparing to make a guideline.

In addition, there are now plans to formulate improvements to safety measures, including effective accident management measures, based on PSA.

Lessons in Category 5

Thoroughly instill a safety culture

(28) Thoroughly instill a safety culture

Thoroughness in safety culture, which is the foundation of nuclear safety, has been strongly recognized anew through this accident.

Because of this, various responses to this accident will be reviewed carefully and Japan is working to rebuild the attitude in which both nuclear plant operators and individuals involved in safety regulation sincerely pursue new knowledge, both as organizations and individuals.

For those engaged in nuclear safety, it is a starting point, an obligation, and a responsibility for each organization and individual to firmly acquire a culture of nuclear safety. The fact that continuous improvement in nuclear safety is impossible when a safety culture is lacking, is being positioned as the starting point for Japan’s ensuring safety in the future. This will be confirmed anew in various forms and will be brought into being.

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