

Specific Countermeasures in Japan Based on the Lessons Learnt from the Accident at Fukushima Dai-ichi Nuclear Power Station of Tokyo Electric Power Co. Inc.

I. Emergency Safety Measures, etc.

1. Emergency Safety Measures

On March 30, the Minister of Economy, Trade and Industry instructed the electric utilities, etc. to implement the following emergency safety measures for other nuclear power stations (NPSs) based on the accident at Fukushima Dai-ichi and Dai-ni NPSs of Tokyo Electric Power Co. Inc. (TEPCO). On May 6, the Nuclear and Industry Safety Agency (NISA) confirmed that these measures (excluding Onagawa, Fukushima Dai-ichi and Dai-ni NPSs) were implemented properly. (Please refer to XI for the overview.) These measures were implemented as necessary measures to avoid serious consequences such as core damage even when there is a total loss of AC power supply, taking into consideration the recent earthquake, and with the understanding that tsunamis pose a clear risk.

These measures ensure the necessary safety against the same level of tsunami attack as the case of the Accident at TEPCO's Fukushima Dai-ichi NPS.

① Measures for the Total Loss of AC Power Supply, etc. [Short Term Measures]

(i) Development and inspection of an emergency response plan

Emergency response plans were developed that took into account estimated damages by a tsunami. Diversification of access routes to areas where required operations are conducted, as well as procedures and authorities related to venting and seawater injection were clarified.

(ii) Securing the power supply in an emergency

Alternative power supplies such as power supply vehicles were secured so that expedient supply of required power would become possible in case the on-site power supply is lost and emergency power cannot be obtained.

(iii) Securing the emergency heat removal function and the emergency cooling function for the Spent Fuel Pool

Recovery measures using expedient heat removal functions such as fire engines and pump trucks, and measures to supply cooling were prepared, in case seawater facilities or functions are lost and the cooling of the Spent Fuel Pool is suspended,

or regular supply of on-site water to the pool is suspended.

(iv) Implementation of emergency response drills and emergency inspection

Emergency inspections on facilities and equipment used for responding to tsunami-induced emergencies were conducted, and the procedure was established through drills that were carried out in connection with measures for the total loss of AC power supply due to a tsunami.

② Actions against Flooding of Buildings [Short-Term Measures]

(v) Measures against flooding of buildings

Measures against flooding were taken for equipment that is used for part of measures for the total loss of AC power supply, so that they would not be impacted by the tsunami.

③ Measures for Improving Reliability by Implementing Speedier Cold Shutdowns [Medium to Long Term Measures]

(vi) Securing back-up equipment such as electric motors for seawater pumps

Plans were developed to secure back-up electric motors for seawater pumps or alternative seawater pumps that are required for the recovery of the permanent Heat Removal System, etc. in order to enable a speedier cold shutdown.

(vii) Installation of air-cooled emergency power generators, etc.

Plans were developed so that large power generators with the capacity to activate heat exchange pumps for removing decay heat would be placed on higher grounds, etc. to make them less susceptible to tsunamis.

④ Protective Measures against Tsunamis [Medium to Long Term Measures]

(viii) Installation of seawalls at the waterfront, installation of flood barriers around the buildings, and making buildings watertight

In order to improve the reliability of the emergency safety measures even further, plans were developed to install seawalls and flood barriers, and to make buildings watertight, so that important equipment for the safety of reactor facilities would not be affected by the tsunami.

2. Instructions to Secure the Reliability of External Power Supplies

On April 15, NISA instructed the electric utilities to establish measures to connect each reactor unit to every circuit of multiple power transmission lines, and to reinforce the transmission towers (power supply lines) as well as anti-flooding measures for switchboards, from the viewpoint of improving the reliability of each NPS by receiving power from off-site power supplies.

3. Other Efforts at the NPSs

In each NPS, there are equipments for observing earthquakes, etc. which record data.

4. Actions by the National and Local Governments, etc.

▪ Enhancement of environmental monitoring

With regard to environmental monitoring, we measured the radiation dose using monitoring cars, etc. and disclosed the information. In addition, the Fukushima Prefectural Government is developing and implementing environmental monitoring plans.

▪ Enhanced decision making functions at the national and local levels

Emergency response in the accident was carried out using peripheral facilities such as the Fukushima Prefectural Office and J-Village, etc. In addition, organizations such as the Integrated Response Headquarters for the Fukushima NPS Accident (currently called the Government-TEPCO Integrated Response Office, hereinafter referred to as the “Integrated Response Office”) and Nuclear Sufferers Life Support Team were formed in a flexible manner and actions such as sharing of information or provision of quick support were taken according to the issues.

▪ Enhancement of public relations

The national government strived to enhance communication with local residents, etc. by dispatching staffs, including top officials from related government ministries and agencies, distributing newsletters to evacuation centers, providing information through local radio programs, etc., and giving briefings about the response to the accident at TEPCO’s Fukushima NPSs and about the emergency safety measures to local governments of the prefectures with NPSs.

- Responding to support from each country and enhancement of communication with the international community

The national government has tried to build collaborative relationships within the government and with donor countries in order to receive assistance from each country. In addition, the government has been striving to provide prompt and accurate information to the International Atomic Energy Agency (IAEA) and to each country through the IAEA. The government has also strived to promote correct understanding about the accident and the effects of the accident as well as the government's response, by briefing foreign embassies in Tokyo and foreign media. Furthermore, the government has been urging the international community to respond to the import bans on Japanese products by foreign countries on scientific grounds.

- Accurate understanding and estimation of the impact of the release of radioactive materials

The government has been publishing analyses based on SPEEDI (System for Prediction of Environmental Emergency Dose Information) from the viewpoint of effectively utilizing SPEEDI.

- Clarification of the definition of the wide-area evacuation during a nuclear hazard and the radiation protection standards

The government established the Deliberate Evacuation Area and Evacuation-Prepared Area in Case of Emergency, and carried out the evacuations after giving a clear explanation on the government's point of view. In addition, provisional regulation values were established related to the standards for food safety, and indicators, etc. were established related to the restriction of intake of tap water.

- Enhancement of the regulatory and administrative structure for nuclear safety

The government responded and established organizations in a flexible manner, such as the Nuclear Emergency Response Headquarters, the Integrated Response Office, and Nuclear Sufferers Life Support Team, etc. according to the issues, in order to share information and provide quick support.

- Maintenance and enhancement of the legal system, standards and guidelines

The government ensured that aging management is steadily implemented and conducted on-site inspections to confirm and evaluate the implementation status of aging nuclear plants.

- Enhancement of health management of workers engaged in emergency work and confirmation of the management structure

The government has been ensuring that radiation dose exposure management of workers and ad-hoc health examinations would be thoroughly implemented. The government has also been confirming the radiation exposure management by requiring notices to be submitted when certain emergency work is conducted. In addition, long term health management of workers will be carried out by building a database for radiation exposure dose, etc.

- Securing personnel related to nuclear safety and nuclear disaster prevention

NISA, the agency responsible for regulating nuclear safety, has established HR development programs and has actively promoted training, etc. of personnel.

II. Additional Emergency Safety Measures

In addition to the above-mentioned emergency safety measures, NISA also requested that the utilities implement the following measures by the end of June as part of additional emergency measures taking into consideration the accident at TEPCO's Fukushima NPS, from the viewpoint of enabling more speedy action in case a severe accident breaks out. The government also decided to establish measures immediately.

- Enhancing measures against hydrogen explosions

For BWRs, the utilities are required to establish procedures for the measures aiming to prevent hydrogen explosions, as well as carry out drills, and obtain outlets for venting hydrogen such as by securing the means to open the blow-out panels. For PWRs, the utilities are required to obtain power supply for annulus exhaust facilities using power supply vehicles, and obtain power supply for igniters (hydrogen combustors) using power supply vehicles in case there is a leakage of hydrogen and the emission of hydrogen is required.

- Enhancing the environment for accident response

The utilities are required to improve the infrastructure for responding to accidents by obtaining emergency power supplies for the PHS communication facilities inside the plant, by securing communication means inside the plant such as transceivers, by obtaining portable lighting equipment, and by maintaining the radiation shielding function in the Main Control Room by installing HVAC systems using emergency power supply cars.

- Enhancing the management for radiation exposure control during an accident

Considering the number of workers to be engaged in operation during an emergency, the utilities are required to obtain sufficient number of personal dosimeters in case of an accident. In

addition, they were required to establish a structure that will enable the expansion of radiation control staff during an accident.

- Management of emergency response supplies and equipments

In order to carry out recovery work promptly during an accident, the utilities are required to deploy sufficient number of heavy machineries for the removal of rubble, etc. They are also required to obtain protective masks and protecting clothing for carrying out work under high radiation dose conditions and to clarify procedures that would enable utilities to share the supplies amongst one another when accident response work is being carried out.

- Enhancement of external communication

The government will give detailed explanations to local governments, etc. about new measures including this report, and ways to ensure security and nuclear disaster prevention in the future.

- Accurate understanding and estimation of the impact of the release of radioactive materials

The government will review the manual that describes the procedure for the prompt disclosure of the SPEEDI analysis results and explanation to local governments and residents, based on the assumption that sufficient information regarding the source of the release is not available due to the accident.

III. Medium to Long Term Measures for Further Safety Enhancement

In addition to the above-mentioned short-term measures, we decided to include the following points to be implemented in the future in addition to the already planned emergency safety measures, taking into consideration new facts that would come out before the measures are implemented, as part of medium to long-term measures that would make the accident response at TEPCO's Fukushima Dai-ichi NPS become more secure, prompt and permanent.

1. Enhancement of Preventive Measures against Severe Accidents

- Enhancement of measures against earthquakes and tsunamis

A mechanism analysis, etc. on the occurrence of the recent earthquake and tsunami will be conducted, and the findings will be reflected on the seismic back check. The current seismic back check will be accelerated and terminated at an early timing. In addition, we will consider whether it is necessary to legally require conformity to the revised Regulatory Guide for

Reviewing Seismic Design of Nuclear Power Reactor Facilities (introduction of backfit), with the aim to implement them within the next three years. Furthermore, we will consider whether further revision of the regulatory guide (including the classification of the importance of facilities) based on the recent accident is required. Regarding back checks, we will consider whether means to implement anti-earthquake and tsunami measures by setting target levels in advance would be required, since it takes a long time to estimate earthquakes based on historical earthquakes and tsunamis, and fault investigations. In addition, we will consider whether the establishment of seawalls and other anti-tsunami measures should be included in the regulations.

Furthermore, since measures against terrorism, which is another external event, are becoming more and more important in recent years, and because the measures that take into account the recent accident are also conducive to effective counterterrorism, we will request the utilities to establish measures to further enhance protective measures, by thoroughly implementing intrusion prevention of unauthorized personnel, etc. by collaborating with the security authorities in order to make assurance doubly sure.

- Securing power supply

We will request the utilities to establish measures for securing emergency power supply such as installing large capacity secondary batteries, and making them rechargeable from existing back-up power supplies, distributed deployment of control equipment and power panels that are important for safety, such as by placing them on higher floors or grounds in order to prevent total loss of function due to flooding, seismic reinforcement of switchyard facilities, seismic enhancement of fuel tanks for emergency power supplies, and improvement of fuel oil procurement systems necessary for securing emergency power supply, etc. We will also consider whether the diversification of cooling methods of on-site power supplies (e.g. air-cooling and water-cooling) should be legally required.

- Securing reliable cooling functions for reactors and PCVs

We will request the utilities to establish measures necessary for obtaining the water source for injecting water into the reactors and PCVs, such as seismic reinforcement of water intake pits and large size fresh water tanks, measures required for obtaining the secure means of water injection, such as enhancement of inspection on PCV spraying equipment, etc., installation of suction pumps at storage ponds and seawater pits, and installation of pumps and injection equipment that will enable external injection into the reactors and steam generators without power supplies (e.g. DG-driven pumps, pressurized pumps, etc.). Furthermore, we will request the utilities to establish necessary measures for securing heat sinks in order to remove waste

heat from decay heat and components, etc. by installing water intake pits for cooling using seawater, deployment of reserve intake pumps, diversification of intake points, and development and establishment of air-cooling type cooling systems, etc.

- Securing reliable cooling functions for the Spent Fuel Pool

We will request the utilities to establish measures required for obtaining secure cooling functions for the Spent Fuel Pool such as seismic reinforcement of pipes, etc. that are part of the Cooling System for the Spent Fuel Pool, obtaining power supply for the water level gauge and temperature gauge of the Spent Fuel Pool from emergency power supplies, enhancement of the inspection of cooling pumps, etc. for the Spent Fuel Pool, enhanced monitoring (ITV, etc.) of the condition for the Spent Fuel Pool, and the introduction of dry cask storage. We will also review the regulation regarding the storage (e.g. location, storage period) of spent fuel.

- Thorough implementation of accident management (AM)

The government will examine measures to prevent severe accidents that occur only rarely but can cause tremendous damage by reviewing design requirements and utilizing the Probabilistic Safety Assessment (PSA) methodology. We will also legalize the AM measures with expanded coverage. In this process, we will establish and utilize the methodologies for fire and earthquake PSA.

*Probabilistic Safety Assessment (PSA): The methodology for calculating the probability of core damage due the occurrence of an initiating event such as the loss of external power supply. By utilizing the PSA method to identify design vulnerabilities in advance, we can use the information to prevent accidents from occurring or exacerbating.

- Response to issues regarding multiple reactor locations

We will request utilities to establish measures required to respond to issues where multiple reactors are located on the same site, such as proper isolation of units and buildings to ensure safety, and obtaining independence of the locations of multiple units from an engineering standpoint, etc. (such as appropriate layout of reactor buildings and turbine buildings).

- Basic design considerations for the layout, etc. of NPSs

We will consider whether to review the regulations regarding storage (e.g. location) of spent fuel (already announced) and require the utilities to place reactor buildings and turbine buildings based on appropriate layouts (already announced).

- Water-tightening of the important equipment and facilities

We will request utilities to establish measures required for making important equipment and facilities water-tight, such as placing control equipment that are important for safety in dispersed locations and on higher floors or ground. (Already announced.)

2. Enhancement of Measures Against Severe Accidents

- Reinforcement of measures against hydrogen explosions

We will request utilities to establish measures required for reinforcing the measures against hydrogen explosions such as implementation of measures to prevent hydrogen buildup by installing combustible gas concentration control systems in BWR reactor buildings, installation of hydrogen detectors inside the BWR reactor buildings based on investigation of the event (leakage path) that occurred in TEPCO's Fukushima Dai-ichi NPS, installation of hydrogen venting equipment (hydrogen vents) in the BWR reactor buildings, and installation of static/catalytic hydrogen bonding equipment for PWR PCVs.

- Enhancement of PCV venting systems

We will request utilities to establish measures required for enhancing PCV venting systems by installing filters, etc. in the vents, evaluating and reviewing the design and operation conditions of the rupture discs, installing accumulators in the AO valves of the vents, and enhancing the independence of the vent exhaust line (prevention of leakage to the neighboring reactor unit) assuming an accident scenario.

- Enhancement of accident response environment

We will request utilities to establish measures for enhancing the environment for responding to accidents such as reinforcing the communication system (diversification of power supplies, etc.), enhancing the functionality of the emergency response office (earthquake resistance, shielding, securing capacity of accommodating the required personnel, etc.), and seismic reinforcement of the administrative building, etc.

- Enhancement of training for responding to severe accidents

We will request the utilities to enhance training to respond to severe accidents envisioning severe accidents caused by incidents such as a rupture of the primary coolant pipe, etc., which become prolonged and aggravated.

We will also request the utilities to enhance training for anti-terrorism which is becoming more and more important in the recent years.

- Enhancement of instruments to assess the situation of reactors and PCVs

We will request utilities to enhance instruments for assessing the situation by developing and equipping the instruments for RPVs, PCVs and Spent Fuel Pools that function sufficiently even in a severe accident.

- Maintenance of supplies and equipment for emergency response and establishment of rescue teams

We will request the utilities to establish a central control system to manage the emergency supplies and equipments including robots and unmanned helicopters, to establish a rescue team that has a good disaster response expertise to operate this equipment, and to enhance collaboration with authorities concerned.

3. Enhancement of Nuclear Disaster Response

- Facilitation of local and central decision making processes

The government will enhance the facilities in the off-site centers including communication systems and review the operation manual of them.

In addition, we will arrange alternative centers (back up off-site centers) and reinforce the frontline bases (for on-site activities) on the NPS site, functions of which are equivalent to those of J-Village and Onahama Call Center had currently. Through these measures, the local Nuclear Emergency Response Headquarters will be able function more sufficiently in terms of both hardware side and software side.

Furthermore, we will consider improving network between all utilities and related authorities by the TV conference system for the emergency, which currently connects the prime minister's office and government agencies, including NISA.

Moreover, by reviewing the relevant laws and regulations, we will consider reinforce the relevant laws to enable the local and government headquarters, the central government, the off-site and on-site center to respond quickly.

- Enhancement and reinforcement of nuclear disaster drills

The government will consider enhancing and reinforcing comprehensive disaster-preparedness drills by clarifying and disseminating information about the disaster response procedures, etc. based on the challenges seen in the response to the recent accident at TEPCO's Fukushima Da-ichi NPS.

- Response to combination of natural disasters and nuclear accidents

The government will review measures not only for individual disasters, but also for combination of disasters in the Central Disaster Prevention Council, etc., in a cross-ministerial manner. The agenda will include the review of full readiness and the command structure of the relevant ministries. The local governments will be requested to reflect the outcome of the discussion on their disaster prevention plans.

- Enhancement of environmental monitoring

The government will establish measures to enhance environmental monitoring by establishing procedures to promptly collect and disclose on-site and off-site monitoring data, enhancing unmanned airborne monitoring, and introducing wide-area diffusion assessment in order to build a structure to implement environmental monitoring in a steady and planned manner.

- Enhancement of public relations

From the viewpoint of enhancing information disclosure to the public and issuing instructions for evacuation, etc. to residents in the surrounding areas, the government will consider expanding the Emergency Planning Zone (EPZ) and request the local government to review the disaster prevention plan, and also establish procedures of publication about the evaluation of the accident and the progress of the accident response (risk communication).

- Enhancement of response to assistance from foreign countries and information provision to the international community

The government will confirm and strengthen the collaborative structure within the government and with donor countries in order to receive assistance such as supplies and equipments from foreign countries. With regard to the provision of information to the international community, we will improve the relevant international frameworks, offer more accurate information promptly that will facilitate response based on scientific grounds, and review the way information is shared with other countries, international organizations and foreign media.

- Improvement of estimation of the impact of the release of radioactive materials

The government will enhance the ERSS (Emergency Response Support System) to obtain data about the impact of the release of radioactive materials more accurately and inclusively, establish the procedure of swift publication about the drawings of the release of radioactive materials on an hourly basis from SPEEDI, and introduce wide-area diffusion assessment.

- Clarification of the standard of wide-area evacuation and radiation protection standards during a nuclear accident

The government will review the Emergency Planning Zones (EPZ) related to radiation protection, establish standards for foods, and establish the standard of the exposure of the general public divided into those for adults and children during a nuclear accident.

4. Enhancement of the Infrastructure for Securing Nuclear Safety

- Enhancement of the nuclear safety regulations and emergency preparedness and response system

The government will clarify the mandate of each ministry and agency related to nuclear safety regulations and environmental monitoring, by separating NISA from the Ministry of Economy, Trade and Industry, and starting discussion about the other organization such as NSC.

The government will also improve disaster prevention scheme, including emergency response at the plants, evacuation and securing the safety of residents, assistance for nuclear sufferers, environmental monitoring, radiation protection (suspension of shipment of foods and restriction of intake of foods and tap-water), medical support and anti-terrorism measures, through reforming the roles, mandates and organizations and expanding.

- Reform of Provision and enhancement of the regulatory framework, standards and guidelines

The government will review the regulatory framework and standards related to nuclear safety and emergency preparedness and response incorporating the findings from the causes of this accident, and consider legislations of so-called back fit, which applies new laws and regulations to already licensed facilities. In addition, based on the analysis of the recent accident, we will conduct detailed evaluation on whether the deterioration based on aging (such as embrittlement, fatigue, thermal aging, cable insulation deterioration of the PCV) has any effect on the damage or decline of functions of the facilities. We will also verify the connection between the types of reactors and the cause of the accident, as well as evaluate and improve the reactor designs (by utilizing periodic safety reviews, etc.) in order to improve the reliability of the existing reactors based on the technological advancement in reactor designs.

- Securing human resource related to nuclear safety and emergency preparedness and response

In order to obtain sufficient personnel related to nuclear safety and emergency preparedness and response, the government will work with the utilities to strengthen collaboration with educational institutions to build a network of nuclear specialists, enhance HR development in regulatory agencies and specialized agencies, conduct active hiring and exchange of specialists

between the public and private sectors, and organize specialists to enable response from both on-site and off-site centers.

- Enhancement of regulatory requirements to ensure independence and diversity of safety systems

The government will consider safety regulatory requirements about locations of safety equipments such as emergency power generators and seawater cooling systems (e.g., location of a seawater intake), and also about independence and diversity of cooling methods.

(E.g., Dispersed layouts taking into account hazards such as tsunami, and adoption of both air-cooling and seawater cooling methods).

- Effective utilization of Probabilistic Safety Assessment (PSA) methods for risk management

The government will review the design requirements for NPSs, promote the introduction of PSA for fires, earthquakes and tsunami, and develop legislations for measures against severe accidents, in order to realize measures to improve safety utilizing the PSA methodology.

5. Comprehensive Implementation of a Safety Culture

- Comprehensive implementation of a safety culture

The government and utilities will establish organizational safety targets, promote, evaluate and improve activities to foster the safety culture among individuals and organizations, enhance collaboration with educational institutions and train personnel for the regulatory agency so that every person engaged in nuclear power will be familiar with a safety culture and make continuous improvements for nuclear safety.