Contents of Summary

1. Introduction

The Tohoku District - off the Coast of Pacific Ocean Earthquake and tsunami caused by the earthquake attacked the Fukushima Dai-ichi and Fukushima Dai-ni Nuclear Power Stations (hereinafter referred to as “Fukushima NPS”) of Tokyo Electric Power Co. (TEPCO) at 14:46 on March 11, 2011 (JST, the same shall apply hereinafter) and nuclear accident followed at an unprecedented scale and over a lengthy period.

For Japan, the situation has become extremely severe since countermeasures to deal with the nuclear accident have had to be carried out along with dealing with the broader disaster caused by the earthquake and tsunami.

This nuclear accident has turned to be a major challenge for Japan, and Japan is now responding to the situation, with the relevant domestic organizations working together, and with support from many countries around the world. Japan also takes it very seriously and with remorse that this accident has raised concerns around the world about the safety of nuclear power generation. And above all Japan feels sincere regret for causing anxiety among the people all over the world about the safety of nuclear power facilities and the release of radioactive materials.

Currently, Japan is dealing with the issues and working towards restoration from the accident utilizing accumulated experience and knowledge. It is Japan's responsibility to share correct and precise information with the world continuously in terms of what happened in Fukushima NPS, including details about how the events progressed, and how Japan has been working to settle the accident. Japan also recognizes it as its responsibility to share with the world the lessons it has learned from this process.

This report is prepared based on the recognition mentioned above, as the report from Japan for the International Atomic Energy Agency (IAEA) Ministerial Conference on Nuclear Safety which will be convened in June 2011. The Government-TEPCO Integrated Response Office is engaged in working toward restoration from the accident under the supervision of Mr. Banri Kaieda, the Minister of Economy, Trade and Industry in conjunction with and joining forces with the Nuclear and Industrial Safety Agency, and TEPCO. Preparation of this report was carried out by the Government Nuclear Emergency Response Headquarters in considering the approach taken by the Government-TEPCO Integrated Response Office toward restoration, and by hearing the opinions from outside experts. The work has been managed as a whole by Mr. Goshi Hosono, Special Advisor to the Prime Minister, who was designated by the Prime Minister Kan in his capacity as General Manager of the Government Nuclear Emergency Response Headquarters (GNER HQs).

This report is a preliminary accident report, and represents a summary of the evaluation of the accident and the lessons learned to date based on the facts gleaned about the situation so far. In terms of the range of the summary, technical matters related to nuclear safety and nuclear emergency preparedness and responses at this moment are centered on, and issues related to compensation for nuclear damage and the wider societal effects and so on are not included.

On top of preparing this report, the Government has established the "Investigation Committee on the Accidents at the Fukushima Nuclear Power Station of Tokyo Electric Power Company" (hereinafter referred to as "the Investigation Committee") in order to provide an overall investigation of the utility of countermeasures being taken against the accident that has occurred in Fukushima NPS. In this Investigation Committee, independence from Japan's existing nuclear energy administration, openness to the public and international community, and comprehensiveness in examining various issues related not only to technical elements but also to institutional aspects, are stressed. These concepts are used as the base to strictly investigate all activities undertaken so far, including activities by the Government in terms of countermeasures against the accident. The contents of this report will also be investigated by the Investigation Committee, and the progress of the investigation activities will be released to the world.

Japan's basic policy is to release the information about this accident with a high degree of transparency. In terms of the preparation of this report under this policy, we have paid attention to providing as accurately as possible an exact description of the facts of the situation, together with an objective evaluation of countermeasures against the accidents, providing a clear distinction between known and unknown matters. Factual descriptions are based on the things that were found by May 31, this year.

Japan intends to exert all its power to properly tackle the investigation and analysis of this accident, and to continue to provide those outcomes to both to the IAEA and to the world as a whole.

2. Situation of Nuclear Safety Regulations and Other Regulatory Frameworks in Japan before the Accident

Safety Regulations for NPSs in Japan are mandated under the "Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors" and "The Electricity Business Act". The Nuclear and Industrial Safety Agency (NISA) in the Ministry of Economy, Trade and Industry is responsible for these regulations. The Nuclear Safety Commission (NSC), which is established under the Cabinet Office, has a role to supervise and audit the safety regulation activities implemented by NISA, and has the authority to make recommendations through Prime Minister to the Minister of Economy, Trade and Industry to take necessary measures, if necessary. When the Minister of Economy, Trade and Industry issues a license to establish an NPS, the Minister has to seek opinions from the NSC regarding safety issues beforehand.

The monitoring and the measurement activities for preventing radiation damages and for evaluating radioactivity levels are carried out by related government agencies including the Ministry of Education, Culture, Sports, Science & Technology (MEXT) based on the related laws and regulations.

Responses to nuclear accidents in Japan are supposed to be carried out based on the Act on Special Measures Concerning Nuclear Emergency Preparedness, (hereinafter referred to as

"ASMCNE"), which was established after the occurrence of the criticality accident in a JCO nuclear fuel fabrication facility in 1999. ASMCNE complements the Disaster Countermeasures Basic Law should a nuclear emergency occur. ASMCNE stipulates that the national and local governments, and the licensee shall address a nuclear emergency by closely coordinating each other, that the Prime Minister shall declare a nuclear emergency situation in response to the occurrence of a nuclear emergency situation and give instructions to evacuate the area or to take shelter as appropriate, and that the GNER HQs headed by the Prime Minister shall be established to respond to the situations etc.

Emergency environmental monitoring, which is one of the responses to be taken at the time of a nuclear disaster, shall be implemented by local governments and supported by MEXT.

3. Disaster Damage by Tohoku District - off the Pacific Ocean Earthquake and Tsunami in Japan

The Pacific coast area of eastern Japan was attacked by the Tohoku District - off the Pacific Ocean Earthquake, which occurred at 14:46 on March 11, 2011. This earthquake occurred in an area where the Pacific plate sinks beneath the North American plate and the magnitude of this earthquake was 9.0, which is the largest, recorded in the history in Japan. Seismic source was at latitude 38.1 north, longitude 142.9 east and at a depth of 23.7km.

The crustal movement induced by this earthquake extended over a wide range, from the Tohoku District to Kanto District. Afterwards, tsunamis attacked the Tohoku District in a series of seven waves, resulting in the inundation of an area as large as 561km^2. At the time of issuing this report, approximately 25,000 people are reported dead or missing.

In terms of the earthquake observed in Fukushima NPS, the acceleration response spectra of the earthquake movement observed on the basic board of reactor buildings exceeded the acceleration response spectra of the basic earthquake movement in design for partial periodic bands in Fukushima Dai-ichi NPS. As for Fukushima Dai-ni NPS, the acceleration response spectra of the earthquake movement observed on the basic board of the reactor buildings was below the acceleration response spectra of the basic earthquake movement in design. The earthquake damaged the external power supply.

Thus far, major damages to the reactor facilities which are important for safety function has yet to be recognized. Further investigations are needed because there are still unknown detailed situations.

In terms of the damage to the external power supply in Fukushima NPS, a total of 6 external power supply sources had been connected to the Dai-ichi Power Station on the day the earthquake hit. However, all power supplies from these 6 lines stopped due to the damage to the breakers, etc. and the collapse of the power transmission line tower due to the earthquake. Further, in the Fukushima Dai-ni NPS, on the day of the earthquake, a total of 4 external power supply sources were connected, but, only one of them remained to supply electricity as among the rest of them, one line was under maintenance, one stopped due to the earthquake, and another one also stopped (After the completion of restoration works at 13:38 on the next day, March 12, one power supply was restored, and two sources supplied the electricity thereafter.)

With respect to the tsunami onslaught, Fukushima Dai-ichi NPS was hit by the first enormous wave at 15:27 on March 11 (41 minutes after the earthquake), and the next enormous wave around 15:35. As for Fukushima Dai-ni NPS, it was hit by the first enormous wave at around 15:23 (37 minutes after the earthquake) and by the next enormous wave at around 15:35. (Based on TEPCO's announcement.) The license for the establishment of nuclear reactors in Fukushima Dai-ichi NPS was based on the assumption that the maximum size of expected tsunami is 3.1 m on the design-basis. The assessment in 2002 based on "Tsunami Assessment Method for Nuclear Power Plants in Japan" proposed by the Japan Society of Civil Engineers (JSCE) showed that the maximum water level would be 5.7m, and TEPCO rose the height of seawater pump installation in Unit 6 responding to that assessment. However, the actual tsunami height this time was 14 to 15m, and the seawater pump facilities for cooling auxiliary systems in all units were submerged and stopped their functions, and in addition to that, all the emergency diesel power generators and the distribution boards installed in the basement of the reactor buildings and turbine buildings except for Unit 6 were inundated and stopped their functions.

For Fukushima Dai-ni NPS, the maximum tsunami height was expected to be 3.1 to 3.7m on the design-basis Further, the said assessment by JSCE in 2002 showed that the maximum water level would be 5.1 to 5.2m. Because of the tsunami, most of seawater pump facilities for cooling auxiliary systems except for some were submerged and stopped their functions, and the emergency diesel power generators installed in the basement of the reactor buildings stopped.

Thus, the assumption of and the preparedness for an onslaught of enormous tsunami were not sufficient.

4. Occurrence and Development of the Accident in Fukushima Nuclear Power Stations

(1) Outline of Fukushima Nuclear Power Station

Fukushima Dai-ichi NPS is located in the towns of Okuma and Futaba of Futaba County in Fukushima Prefecture, and consists of 6 Boiling Water Reactors (BWR); Units 1 to 6 are installed, whose total generating capacity is 4,696 MW.

Fukushima Dai-ni NPS is located in the towns of Tomioka and Naraha of Futaba county in Fukushima Prefecture, and consists of 4 BWRs whose total generating capacity is 4,400 MW.

(2) Status of safety assurance for Fukushima NPS

In facilities with nuclear reactor, occurrence of failures has to be prevented even if natural phenomenon, etc. should occur. However, presuming that failures may nevertheless happen, protective measures are provided to secure safety even when the unusual situation of design basis event should happen. In addition, Japan started taking accident management measures in 1992, which would minimize the possibility of reaching the state of a severe accident as much as possible when these protective measures are not enough and would mitigate the effects even when the situation reached the state of severe accident. Implementation of the accident management measures is not required by law on the safety regulations. The accident management measures are implemented by nuclear operators voluntarily, and the government requires them to make reports on their implementation.

The accident management measures in Fukushima NPS are implemented for the following four functions; the functions to shutdown the nuclear reactor, the functions to inject water into nuclear reactors and PCV, the functions to remove heat from PCV, and the functions to support the safety functions. For example, measures to maintain functions to inject water into the nuclear reactor includes that the connection to the piping be secured for water injection functions to nuclear reactors through PCV cooling system and the core spray system from the existing Make Up Water Condensate (MUWC) system and the fire extinguishing system to be utilized as the alternative water-injection equipment.

(* Severe Accident: An event that significantly exceeds the design basis event, and the situation where appropriate cooling for the reactor core or control of reactivity is rendered inoperable by the postulated measures under the evaluation for safety design, resulting in serious damage to the reactor core.)

(**Accident Management: Measures taken to prevent an event leading to a severe accident, or to mitigate its influence in the event of a severe accident, by utilizing a) functions other than the anticipated primary ones under the safety margin and safety design included in the current design or b) newly installed equipment in preparation for a severe accident, etc.)

(3) Operational status of Fukushima NPS before the earthquake

In terms of the operating status in Fukushima NPS before the earthquake on March 11, Unit 1 was under operation at its rated electric power, Units 2 and 3 were under operation at their rated thermal power, and Units 4, 5 and 6 were under periodical inspection. Among these Units, Unit 4 was undergoing a major renovation construction, and all the nuclear fuel in the RPV had already been transferred to the spent fuel pool. Moreover, 6,375 units of spent fuel were stored in the common spent fuel pool.

In Fukushima Dai-ni NPS, all nuclear reactors, Units 1 to 4 were under operation at their rated thermal power.

(4) The outbreak and development of the accident in Fukushima NPS

In Fukushima Dai-ichi NPS, Units 1 to 3 which were under operation automatically shut down at 14:46 on March 11. All of the six external power supply sources were lost because of the earthquake. This caused the emergency diesel power generators to start up. However, seawater pumps, emergency diesel generators and distribution boards were submerged because of the tsunami onslaught, and all emergency diesel power generators stopped except for one generator in Unit 6. For that reason, all AC power supplies were lost except for Unit 6. One emergency diesel power generator (an air-cooled type) and the distribution board escaped submersion and continued operation in Unit6. In addition, since the seawater pumps were submerged by the tsunami, residual heat removal systems to release the residual heat inside the reactor to the seawater and the auxiliary cooling system to release the heat of many equipments to the seawater lost their functions..

Operators of TEPCO followed TEPCO's manuals for severe accidents and urgently attempted to secure power supplies in cooperation with the government, in order to recover many equipments of the safety systems while the core cooling equipment and the water-injection equipment which automatically started up were operating. However, they could not secure power supplies after all.

Since the core cooling functions using AC power were lost in Units 1 to 3, the core cooling functions without using AC power operated or attempted were made to that end. These are the operation of the Isolation condenser*** in Unit 1, the operation of reactor core isolation cooling system**** (RCIC) in Unit 2 and the operation of RCIC and high pressure injection system***** (HPCI) in Unit 3.

These core cooling systems that do not utilize AC power supplies stopped functioning thereafter, and were switched to alternative injection of fresh water or sea water by the fire distinguishing line using fire engine pumps.

Concerning Units 1 to 3 of Fukushima Dai-ichi NPS, as the situation where water injection to each RPV was impossible continued for a certain period of time, nuclear fuels in each reactor core were not covered by water but were exposed, and led to a core melt. A part of the melted fuel stayed at the bottom of the RPV.

A large amount of hydrogen was generated by chemical reactions between the zirconium of the fuel cladding tubes etc. and water vapor. In addition, the fuel cladding tubes were damaged and radioactive materials therein were discharged into the RPV. Further, these hydrogen and radioactive materials were discharged into the PCV during the depressurization process of the RPV.

Injected water vaporizes after absorbing heat from the nuclear fuel in the RPV. Accordingly, the inner pressure rose in the RPV which lost its core cooling function, and this water vapor leaked through the safety valves into the PCV. Due to this, the inner pressure of the PCVs in Units 1 to 3 rose gradually, and the PCV wet well vent operations were carried out a number of times where the gas in the PCVs are released from the gas phase area in the suppression chamber into the atmosphere, through the ventilation stack, for the purpose of preventing damage of the PCV caused by the pressure therein.

(*** Isolation condenser: The equipment with the function to return water condensed from water-vapor in the RPV by natural circulation (pump driving is not required) to cool the RPV, when the RPV is isolated due to the loss of external power supply etc. (when reactor cooling cannot be done by the main condenser). Isolation condenser has the structure to cool the water-vapor that was lead into the heat transfer tube with the water stored in condenser (body side).

(**** Reactor core isolation cooling system (RCIC): The system that cools the reactor cores when reactors are isolated from feed water and condenser systems due to the loss of external power, etc. Either the condensate storage tank or the pressure suppression pool water can be used as water source. The driving system for the pump is a turbine which uses some of the steam in the reactors)

(***** High pressure injection system (HPCI): One of the emergency core cooling systems that injects water with the pump driven by providing the water-vapor generated by the decay heat to the turbine.)

After the wet well venting of the PCVs, explosions presumably caused by hydrogen which leaked from the PCV occurred in the upper area of the reactor buildings, and broke the operation floor in the reactor buildings of Units 1 and 3. As a result of these incidents, a lot of radioactive materials were discharged to the atmosphere. Following the breaking of the Unit 3 building, an explosion probably caused by hydrogen, occurred in the reactor building of the Unit 4 and broke its upper area. In Unit 4, all core fuels were transferred to the spent fuel pool for periodical inspection before the earthquake. During this time, it seems that in Unit 2 a hydrogen explosion occurred and caused damage at the point, presumably near the suppression chamber.

The most urgent task at the site along with recovery of power supply and continuation of water injection to reactor vessels was water injection to the spent fuel pools. In the spent fuel pool in each unit, the water level continued to drop with the evaporation of water caused by the heat of the spent fuel in the absence of pool water cooling system due to the loss of power supply. Water injection to the spent fuel pool was carried out by the Self-defense Forces, the Fire and Disaster Management Agency and the National Police Agency using the helicopters and water cannon trucks. Concrete pump trucks were secured in the end, which led to stable water injection using fresh water in the nearby reservoirs after the initial seawater injection.

(5) Status of each Unit in Fukushima NPS

1) Fukushima Dai-ichi NPS Unit 1

· (Loss of power supply) The reactor was scrammed by the earthquake that occurred at 14:46, on March 11. The external power supply was lost due to the earthquake and two emergency diesel generators started up. The two emergency diesel generators were stopped by the tsunami at 15:37 on the same day and all AC power was lost.

· (Cooling of the reactor) The emergency isolation condenser* (IC) automatically started up at 14:52 on March 11 and started cooling the reactor. Subsequently, the IC stopped functioning at 15:03 on the same day. According to the operation procedure document, the cooling speed is to be adjusted to 55 degrees Celsius/ hour. The pressure in the reactor rose and fell three times afterwards, which indicates that the IC had been manually operated. According to TEPCO, fresh water injection from a fire extinguishing line started at 05:46 on March 12, using fire engine pump, and 80,000 liters of water- was injected by 14:53 on the same day, but they claim that it is unknown when water-injection stopped. Seawater injection started at 19:04 using the fire extinguishing line. There was some confusion in communications and the chain of command on seawater injection between the government and the main office of TEPCO, but seawater injection continued following the decision by the director of Fukushima Dai-ichi NPS. Injection of fresh water resumed on March 25 with the injection of water stored in the pure water tank. At least for one hour after the earthquake, the water level in the reactor was not low enough to trigger an automatic start-up (L-L: 148cm below the bottom of the separator) of the High Pressure Coolant Injection system (HPCI), and there has been no record of a start-up.

· (Status of the reactor core) Water injection seemed to have stopped since the total loss of AC power at 15:37 on March 11, until the start of fresh water injection at 5:46 on March 12, for 14 hours and 9 minutes. From the results of the evaluation by NISA (on the assumption that the HPCI did not operate), it seems that the fuel was exposed due to a drop of the water level around 17:00 on March 11, and that the core melt started afterwards. A considerable amount of melted fuel seems to have moved to and accumulated at the bottom of the RPV. There is a possibility that the bottom of the RPV was damaged and some of the fuel might have dropped and accumulated on the D/W floor (lower pedestal).

· (Hydrogen explosion) Wet well venting of the PCV was carried out at 14:30 on March 12. Afterwards, a hydrogen explosion occurred in the reactor building at 15:36 on the same day. Zirconium appears to have reacted with water with the rise of the temperature in the RPV, and generated hydrogen. The gas containing the hydrogen accumulated in the upper area of the reactor buildings due to the leakage, etc. from the PCV appears to have triggered the hydrogen explosion. Injecting nitrogen to the PCV started on April 7.

· (Leakage of cooling water) The cooling water which was injected to the RPV appears to be leaking from its bottom. The total amount of water injected to the RPV was approximately 13,700 metric tons (information by TEPCO, as of May 31.), and total generated steam is estimated at 5,100 metric tons. Therefore the amount of leakage seems to be the difference between these two, approximately 8600 metric tons, minus the amount inside the RPV (approximately 350m^3).

2) Fukushima Dai-ichi NPS Unit 2

· (Loss of power supply) The reactor was scrammed by the earthquake at 14:47, on March 11 and the external power supply was lost and two emergency diesel generators started up. The two emergency diesel generators were stopped by the tsunami and all AC power supply was lost at 15:41 on the same day.

· (Cooling of the reactor) TEPCO started up the Reactor Core Isolation Cooling System (RCIC) manually around 14:50 on March 11. The RCIC automatically stopped because of the high water level in the reactor at around 14:51 on the same day. Afterwards, TEPCO manually started it up at 15:02 and it stopped again at 15:28 on the same day. TEPCO started it up again manually at 15:39 on the same day. The RCIC stopped at 13:25 on March 14. Seawater injection using the fire pump started at 19:54 on the same day.

· (Status of the reactor core) Water injection appears to have stopped for 6 hours and 29 minutes from 13:25, on March 14 when the RCIC stopped, until seawater injection resumed at 19:54 on the same day. According to the results of NISA's analysis, it seems that the fuel was exposed due to a drop of the water level at around 18:00 on March 14 and that the core started melting afterwards. A considerable part of melted fuel seems to have moved to and accumulated at the bottom of the RPV. There is a possibility that the bottom of the RPV was damaged and some of the fuel might have dropped and accumulated on the D/W floor (lower pedestal).

· (Explosion noise) A PCV wet vent operation including that of small valves was carried out from around 11:00 on March 13. Noise of an explosion occurred at around 6:00 on March 15 around the suppression chamber of the containment vessel. There is a possibility that the explosion occurred in the torus room, as the gas including hydrogen was generated by a reaction between the zirconium and water, along with the temperature rise in the RPV, invading the suppression chamber through such way as the opening of the main steam safety relief valve.

· (Leakage of cooling water) As of now, injected cooling water is thought to be leaking at the bottom of the RPV. The total amount of injected water to the RPV was approximately 21,000 metric tons (information by TEPCO, as of May 31), and the total generated steam is estimated at 7,900 metric tons. Therefore, the amount of leakage appears to be the difference between these two, approximately 13,100 metric tons minus the amount inside the RPV (approximately 500 m^3).

3) Fukushima Dai-ichi NPS Unit 3

· (Loss of Power supply) The reactor was scrammed by the earthquake at 14:47 on March 11, and the external power supply was lost and two emergency diesel generators started up. The two emergency diesel generators were stopped by the tsunami and all AC power was lost at 15:41 on the same day.

· (Cooling of the reactor) The Reactor Core Isolation Cooling System (RCIC) was manually started at 15:05 on March 11. It stopped automatically at 15:25 on the same day due to the rise of the reactor water level. It was started manually at 16:03 on the same day, and the RCIC stopped at 11:36 on March 12. The High Pressure Core Injection System (HPCI) automatically started due to the reactor low water level (L-2) at 12:35 on the same day, and the HPCI stopped at 2:42 on March 13. The reason for that appears to be a drop of pressure in the reactor. The other probable cause could be water-vapor outflow from the HPCI system.

· (Status of the reactor core) The operation for injection of water containing boric acid commenced using a fire extinguishing line at around 9:25 on March 13. However, the water could not be injected sufficiently due to the high pressure in the reactor, and the water level in the reactor lowered. As a result, water injection was halted at least for 6 hours and 43 minutes after the HPCI stopped at 02:42 on March 13 until water injection using the fire extinguishing line started at 09:25 on the same day. According to the results of NISA's analysis, the fuel appears to have been exposed due to a drop of the reactor water-level at around 08:00 on March 13, and the core started melting afterwards. A considerable part of melted fuel seems to have moved to and accumulated at the bottom of the RPV. However, there is a possibility that the bottom part of the RPV was damaged and some of the fuel might have dropped and accumulated on the dry well floor (lower pedestal).

· (Hydrogen explosion) A wet well vent operation of the PCV was carried out at 05:20 on March 14. A hydrogen explosion occurred at the reactor building at 11:01 on the same day. It seems that zirconium and water reacted along with a rise in the temperature in the PCV, and that gas containing hydrogen by such ways as leakage from the PCV accumulated in the upper area of the reactor buildings triggered a hydrogen explosion.

· (Leakage of cooling water) It is assumed at the moment that injected cooling water is leaking at the bottom of the RPV. The total amount of water injected into the RPV was approximately 20,700 metric tons (information by TEPCO, as of May 31) and the total amount of the steam is estimated to be approximately 8,300 metric tons. A substantial amount equivalent to the difference between these two, approximately 12,400 metric tons minus the amount in the RPV (approximately 500m^3) appears to have been leaked.

4) Fukushima Dai-ichi NPS Unit 4

· (Cooling of the spent fuel pool) The reactor was shut down for periodic inspection. The nuclear fuel had been transferred to the spent fuel pool. External power supply was lost by the earthquake on March 11 and one emergency diesel generator started up. (The other one was under inspection and did not start up.) The emergency diesel generator stopped due to tsunami at 15:38 on the same day, and all AC power was lost. Both the cooling and feed water functions were thus lost. Water spraying over the spent fuel pool started from March 20.

· (Explosion in the reactor building) At around 6:00 on March 15, an explosion in reactor building occurred, and all the walls above the bottom of the operation floor, and the walls on the west side and along the stairs collapsed. A fire broke out near the northwest corner on the 4th floor of reactor building at 09:38 on the same day. With regard to the explosion in the reactor building, one may doubt the possibility of inflow of hydrogen from unit 3 as the exhaust pipe for venting the PCV joins the exhaust pipe from unit 4 before the exhaust stack. However, the cause of explanation has not yet been identified.

5) Fukushima Dai-ichi NPS Unit 5

· (Securing of Power supply) The reactor was shut down for the periodical inspection. The external power supply was lost due to the earthquake at 14:46 on March 11, and two emergency diesel generators started up. However, the two emergency diesel generators stopped at 15:40 on the same day due to the tsunami and all AC power was lost. Alternate power supply was taken from the emergency diesel generator of Unit 6 on March 13, 2011.

· (Cooling of the reactor and the spent fuel pool) Although the operation of the pressure reduction of the RPV was carried out at 06:06 on March 12, the reactor pressure slowly increased due to the effect of decay heat. The alternate power supply was taken from the emergency diesel generator of Unit 6 on March 13, and water injection into the reactor became possible, using the transfer pump for the condenser of Unit 5. Reduction of the pressure by a safety relief valve had been carried out since 05:00 on March 14, and replenishment of the water from the condensate storage tank to the reactor through the transfer pump was repeated to control the pressure and water level of the reactor. To carry out cooling by the residual heat removal system, a temporary seawater pump was installed and started up, and cooling of the reactor and the spent fuel pool was carried out in turn by switching the system constitution for the Residual Heat Removal (RHR) system on March 19. As a result, the reactor reached cold shutdown status at 14:30 on March 20.

6) Fukushima Dai-ichi NPS Unit 6

· (Securing of power supply) The reactor was shut down for the periodical inspection. External power supply was lost due to the earthquake at 14:46 on March 11, and three emergency diesel generators started up. Two emergency diesel generators were stopped by the tsunami at 15:40 on the same day, and the power supply was maintained by the remaining emergency diesel generator.

· (Cooling of the reactor and the spent fuel pool) Reactor pressure rose slowly due to the effect of decay heat. Water injection into the reactor became possible on March 13, using the transfer pump for the condenser with the emergency diesel generator. Reduction of the pressure by a safety relief valve has been carried out since March 14, and replenishment of the water from the condensate storage tank to the reactor through the transfer pump was repeated to control the pressure and the water level of the reactor. To carry out cooling by the residual heat removal system, a temporary seawater pump was installed and started up, and cooling of the reactor and the spent fuel pool was carried out in turn by switching the system constitution for the residual heat removal system on March 19. The reactor reached cold shutdown status at 19:27 on March 20.

7) Fukushima Dai-ni NPS

· (Overall) Reactors from Units 1 to 4 in Fukushima Dai-ni NPS which had been in operation were scrammed at 14:48 on March 11. A total of 4 external power supply lines were connected to this NPS. One line was under maintenance, another stopped due to the earthquake and another stopped one hour after the earthquake, which resulted in the electric supply by one line (The restoration work was completed at 13:38 on March 12, and two lines became available.) The reactors were hit by the tsunami at around 15:34 on the same day and the RHR systems of Unit 1, Unit 2 and Unit 4, etc. were damaged.

· (Unit 1) In terms of the reactor, cooling and water level maintenance were carried out by the reactor core isolation cooling system and Make Up Water Condensate (MUWC) system. However, the temperature of the suppression pool water exceeded 100 degrees Celsius because not all the heat could be removed. Cooling by the dry well spraying started at 07:10 on March 12. Cooling of the suppression pool started with the operation of the RHR system by connecting a temporary cable from the functioning distribution board at 01:24 on March 14. The temperature of the suppression pool became lower than 100 degrees Celsius at 10:15 on the same day, and the reactor reached cold shutdown status at 17:00 on the same day.

· (Unit 2) In terms of the reactor, cooling and water level maintenance were carried out by the reactor core isolation cooling system and the Make Up Water Condensate (MUWC) system. However, the temperature of the suppression pool water exceeded 100 degree Celsius because not all the heat could be removed. Cooling by the dry well spray started at 07:11 on March 12. Cooling of the suppression pool started with the operation of the RHR system by connecting temporary cable as well as Unit 1 at 07:13 on March 14. The temperature of the suppression pool became lower than 100 degrees Celsius at 15:52 on the same day and the reactor reached cold shutdown status at 18:00 on the same day.

· (Unit 3) The RHR system (A) and low pressure core spray system became unusable by the tsunami. However, the RHR system (B) was not damaged and cooling by the same system continued. Therefore the reactor reached cold shutdown status at 12:15 on March 12.

· (Unit 4) In terms of the reactor, although cooling and water level maintenance was carried out by the RCIC and the MUWC system, the temperature of the suppression pool water exceeded 100 degree Celsius because not all the heat could be removed. Cooling of the suppression pool started at 15:42 on March 14 with the operation of the RHR system. The temperature of the suppression pool became lower than 100 degrees Celsius and the reactor reached cold shutdown status at 07:15 on March 15.

(5) Status of the other NPSs

1) Higashidori NPS of Tohoku Electric Power Co.

Higashidori NPS of Tohoku Electric Power Co. (one BWR)was shut down for the periodical inspection, and all fuels in the core were taken out to the spent fuel pool. All three lines of external power supply stopped due to the earthquake, and the power was supplied by an emergency diesel generator.

2) Onagawa NPS of Tohoku Electric Power Co.

In Onagawa NPS of Tohoku Electric Power Co. (BWR Unit 1 to 3) Units 1 and 3 were under operation and Unit 2 was under reactor start-up operation before the occurrence of the earthquake on March 11. All 3 reactors were scrammed by the earthquake. Four of five lines of external power supply stopped due to the earthquake, and one line remained. Unit 1 became on-site power loss and the power was supplied by emergency diesel generators. Water injection into the reactor was carried out by reactor core isolation cooling system, etc. and the reactor reached cold shutdown status at 0:57 on March 12. In Unit 2, the external power supply was maintained and there was no effect on the cooling function of the reactor. In Unit 3, although the external power supply was maintained, auxiliary equipment cooling seawater pump stopped. After that, water injection into the reactor by the RCIC, etc. was conducted and the reactor reached cold shutdown status at 1:17 on March 12.

3) Tokai Dai-ni NPS of Japan Atomic Power Company

Tokai No.2 NPS of Japan Atomic Power Company (one BWR) was under rated thermal power operation, and the reactor was automatically scrammed due to the earthquake at 14:48 on March 11. Although all three lines of external power supply stopped, three emergency diesel generators started up. One of those emergency diesel generators stopped due to the tsunami, but the power supply was secured by the remained two, and the reactor reached cold shutdown status at 0:40 on March 15.

5. Response to Nuclear Emergency

(1) Emergency response after the accident occurred

In Fukushima Dai-ichi NPS, all AC power was lost due to the disaster of the earthquake and the tsunami. In accordance with the Paragraph 1, the Article 10 of the Special Law on Emergency Preparedness for Nuclear Disaster, TEPCO notified the government at 15:42 on March 11, 2011, on that day of the occurrence of the earthquake, that all AC power was lost in Units 1 to 5 in accordance with the Paragraph 1, the Article 10 of the Special Law on Emergency Preparedness for Nuclear Disaster.

After that, TEPCO recognized inability of water injection by the emergency core cooling system in Units 1 and 2 of Fukushima Dai-ichi NPS, and notified the government at 16:45 on the same day of a State of Nuclear Emergency in accordance with the Article 15 of the Special Law on Emergency Preparedness for Nuclear Disaster.

The Prime Minister declared the state of nuclear emergency at 19:03 on the same day, and established the Nuclear Emergency Response Headquarters and the Local Nuclear Emergency Response Headquarters, both of which are headed by the Prime Minister as Director General.

On March 15, the Integrated Headquarters for the Response to the Incident at the Fukushima Nuclear Power Stations (later, renamed as the Government – TEPCO Integrated Response Office on May 9) was established so that the government and the operator could work together in a concerted manner, decide to take necessary measures and promptly response while sharing information on the state of disasters at the nuclear facilities and its necessary measures

The Prime Minister, the Director-General of Nuclear Emergency Response Headquarters determined the evacuation area and the Stay In-house Area according to the judgment of the possibility of discharging radioactive materials, and instructed Fukushima Prefecture and relevant cities, towns and villages to follow the decision. Responding to the status of accidents in Fukushima Dai-ichi NPS, the evacuation area was set at an area within a 3km radius and the Stay In-house Area from a 3 to 10 km radius from the Fukushima Dai-ichi NPS at 21:23, March 11. Afterwards, according to the escalation of events, the evacuation area was expanded to a 20 km radius at 18:25, March 12, and the Stay In-house Area was expanded to a 30 km radius at around 11:00, March 15. Also, responding to the status of accidents in Fukushima Dai-ni NPS, the evacuation area within a 3 km radius and the Stay In-house Area from a 3 to 10 km radius were set at the same time a nuclear emergency situation was declared at 7:45, March 12, the evacuation area was expanded to within 10 km radius at 17:39 on the same day. Then, the evacuation area was changed to within 8 km radius on April 21. Evacuation and Stay In-house instructions immediately after the accident were promptly implemented by a concerted effort by residents in the vicinity, local governments, the police and other relevant authorities.

The Prime Minister pronounced evacuation areas within a 20km radius of Fukushima Dai-ichi NPS as a caution area in accordance with the Basic Act on Disaster Control and instructed the mayors of cities and towns and the heads of villages and concerned local governments to prohibit access to the area on April 21.

The Local Nuclear Emergency Response Headquarters started its activities at Off-Site Center as designated by Basic Plan for Emergency Preparedness. However, it was moved to Fukushima Prefectural Office in Fukushima City due to high-level radiation as the nuclear accident escalated, communication blackout and lack of fuel, food and other necessities caused by logistic congestion around the site.

The longer the accident lasted, the heavier the burden on residents in the vicinity of the NPS became. In particular, many of the residents who were instructed to Stay In-house were voluntarily evacuated and those who remained in the area found it increasingly difficult to sustain their livelihoods due to the congested distribution of goods and logistics problems. To respond to this situation, the government launched support measures.

The primary functions of the Emergency Response Support System (ERSS), which monitors the status of reactors and forecasts the progress of the accident when a nuclear emergency occurs, could not be utilized because necessary information from the plants could not be obtained. In addition, the primary functions of the System for Prediction of Environmental Emergency Dose Information (SPEEDI), which conducts a quantitative forecast of variations of atmospheric concentrations of radioactive materials and air dose rates, could not be utilized because source term information could not be obtained. Although they were used in alternative ways, the process of their operation and disclosure of the results has remained as an issue.

(2)Implementation of the environmental monitoring

In the Basic Plan for Emergency Preparedness, local governments are in charge of environmental monitoring when a nuclear emergency occur. However, most of monitoring posts became dysfunctional at first when the accident occurred. From March 16, it was decided that the Ministry of Education, Culture, Sports, Science and Technology (MEXT) would take charge of summarizing the environmental monitoring carried out by MEXT, local governments and cooperating U.S. organizations.

As for the land area outside the premises of the NPS, MEXT measures the air dose rate, radioactive concentrations in the soil, concentrations of radioactive materials in the air and takes environmental samples in cooperation with the Japan Atomic Energy Agency, Fukushima Prefecture, the Ministry of Defense, and electric companies. MEXT also carries out monitoring by aircraft in cooperation with the Ministry of Defense, TEPCO, the U.S. Department of Energy, etc. TEPCO carries out environmental monitoring at NPS sites and their vicinities, etc.

In terms of sea area near NPS, MEXT, the Fisheries Agency, the Japan Agency for Marine-Earth Science and Technology, the Japan Atomic Energy Agency, TEPCO, and others cooperate with each other to carry out the monitoring of radioactive concentrations, etc. in the seawater and in the seabed. And the Japan Agency for Marine-Earth Science and Technology is simulating the distribution and spread of radioactive concentrations.

The Nuclear Safety Commission evaluates and announces results of these environmental monitoring efforts as they become available.

Environmental monitoring of air, sea and soil of the premises and surrounding areas of Fukushima NPS is conducted by TEPCO.

(3) Measures regarding agricultural products, drinking water, etc.

The Ministry of Health, Labour and Welfare decided that the "Indices relating to limits on food and drink ingestion" indicated by the Nuclear Safety Commission of Japan shall be adopted for the time being as provisional regulation values, and foods which exceed these levels shall not be supplied to the public for consumption pursuant to Food Sanitation Act. The Prime Minister, Director-General of Government Nuclear Emergency Response Headquarters has instructed municipalities concerned to restrict shipments of foods that exceed the provisional regulation level.

In terms of tap water, the Ministry of Health, Labour and Welfare notified departments and agencies concerned in the local governments of the necessity of avoidance of drinking tap water if the radioactive concentration of tap water exceeds the level indicated by the Nuclear Safety Commission from March 19 onward, and released the monitoring results by the local governments concerned, as well.

(4) Measures for additional protected area

It had been revealed, according to the environmental monitoring data that there were areas where radioactive materials were accumulated at high level even outside of the 20 km radius. Therefore, the Prime Minister as Director-General of NERHQs instructed the heads of relevant local governments on April 22 that a deliberate evacuation area on the specific area beyond the 20 km radius needed to be established, and the area between the 20 km and 30 km radius which had been set as the Stay In-house Area excluding the area applicable to deliberate evacuation area within it was renamed as evacuation-prepared area in case of emergency, since the residents there could possibly be instructed to stay in-house or evacuate in case of emergency in future . By this, residents inside the deliberate evacuation area were directed to evacuate deliberately, and residents inside of evacuation-prepared area in case of emergency were directed to prepare for evacuation or for Stay In-house in case of an emergency.

6. Discharge of Radioactive Materials to the Environment

(1) Amount of radioactive materials discharged to the atmosphere

On April 12, both NISA and the Nuclear Safety Commission each announced the total discharged amount of radioactive materials to the atmosphere so far.

NISA estimated the total discharged amount from reactors in Fukushima Dai-ichi NPS according to the analysis results of reactor status, etc. by JNES and presumed that approximately 1.3x 10^{17} Bq of iodine-131 and approximately 6.1x 10^{15} Bq of cesium-137 were discharged. Subsequently, JNES re-analyzed the status of the reactors based on the report which NISA collected on May 16 from TEPCO on the plant data immediately after the accident occurred. Based on this analysis of reactor status and others by JNES, NISA estimated that total discharged amount of iodine-131 and cesium-137 were approximately 1.6 x 10^{17} Bq and 1.5 x 10^{16} Bq respectively. Nuclear Safety Commission estimated the discharged amount of certain nuclides to the atmosphere (discharged between March 11 to April 5) with assistance of the Japan Atomic Energy Agency (JAEA) from the back calculation based on the data of environmental monitoring and air diffusion calculation; the estimations are 1.5 x 10^{17} Bq for iodine-131 and 1.2 x 10^{16} Bq for cesium-137. The discharged amount since early April has been declining and is about 10^{11} Bq/h to 10^{12} Bq/h in iodine-131 equivalent.

(2) Discharged amount of radioactive materials to seawater

The water containing radioactive materials diffused from RPV was leaked into PCV in Fukushima Dai-ichi NPS. Also, because of water injection into the reactors from the outside for cooling, some injected water leaked from PCVs and accumulated in reactor buildings and turbine buildings. The management of contaminated water in reactor buildings and turbine buildings became a critical issue by the standpoint of workability in the buildings, and the management of contaminated water outside of the buildings became a critical issue from the standpoint of the prevention of the diffusion of radioactive materials to the environment.

On April 2, it was discovered that highly contaminated water with radiation level of over 1000 mSv/h had accumulated in the pit of power cables near the water intake of Unit 2 of Fukushima Dai-ichi NPS and it was poured into the seawater. Despite that, the outflow was stopped by stopping work on April 6, and the total discharged amount of radioactive materials was presumed to be approximately 4.7x 10^{15} Bq. As an emergency measure, it was decided that this highly contaminated water would be stored in tanks. However there were no available tanks at the time, and to secure the storage capacity for the contaminated water, low level radioactive water was discharged into the seawater from April 4 to April 10. The total amount of discharged radioactive materials was presumed to be approximately 1.5x 10^{11} Bq.

7. Status of radiation exposure

The government has changed the dose limit for personnel engaged in radiation work from 100 mSv to 250 mSv in the light of present situation of the accidents in order to prevent escalation of the accidents. This is decided based on the information that 500 mSv is the dose limit set for personnel engaged in emergency rescue work to avoid occurrence of deterministic effects provided for in a 1990 recommendation by the International Commission on Radiological Protection.

With regard to the activities by personnel engaged in radiation work in TEPCO, they had no other choice but chief workers would carry personal dosimeters and observe radioactivity for the unit of their work groups, because a lot of personal dosimeters were soaked in seawater and became unusable. Afterwards, personal dosimeters became available, and all workers have been able to carry personal dosimeters since April 1.

The status of exposure doses of personnel engaged in radiation work is as follows. As of May 23, the number of total workers entered in the area was 7,800, and the average exposure dose was 7.7 mSv. The exposure doses for 30 of them were above 100 mSv. The internal exposure measurement of the radiation workers has been delayed and the exposure dose including internal exposure of a certain number of workers could exceed 250 mSv in the future. On March 24, two workers stepped into the accumulated water and their exposure doses were estimated to be less than 2 or 3 Sv.

As for radiation exposure to residents in the vicinity, there were no cases found to harm health in 195,345 (the number as of May 31) residents who received screening in Fukushima Prefecture. All 1, 080 children who went through thyroid gland exposure evaluation received the results lower than the screening level.

The estimation and the evaluation of exposure doses of residents in the vicinity, etc. are planned to be carried out with the use of the results of environmental monitoring, promptly after the survey of evacuation routes and activities conducted mainly by Fukushima prefecture with the assistance of relevant ministries, agencies and the National Institute of Radiological Science, etc.

8. Cooperation with the International Community

Since this nuclear accident occurred in Japan, experts have visited Japan from the United States, France, Russia, The Republic of Korea, China and the United Kingdom, exchanged opinions with concerned organizations in Japan, and gave a lot of advice in terms of stabilization of nuclear reactors and spent fuel pools, prevention of the diffusion of radioactive materials, and countermeasures against radioactive contaminated water. Japan also has received support from these countries and accepted materials required for measures against the nuclear accident.

Experts from international organizations specializing in nuclear power such as the IAEA and the OECD Nuclear Energy Agency (OECD / NEA) visited Japan and provided advice and so on. Also, international organizations such as the IAEA, the World Health Organization (WHO), the ICAO (International Civil Aviation Organization) and the IMO (the International Maritime

Organization), as well as the International Commission on Radiological Protection (ICRP) have provided necessary information to the international community from their technical standpoints.

9. Communication regarding the Accident

Initially after the occurrence of the accident, accurate and timely information was not sufficiently provided, typically shown in the delay of notifications to local governments and municipalities, which has been identified as a challenge in the field of communication on the accident. Transparency, accuracy and rapidity are important in domestic and international communication about accidents. The Japanese Government has utilized various levels and occasions such as press conferences at the Prime Minister's Office and those jointly held by the relevant parties. Although we have improved them as needed, considering what and how information should be provided, we need to continue making efforts to improve communication.

Important issues on the accident have been briefed at press conferences by the Chief Cabinet Secretary to explain to the citizens about the status of the accident as well as the view of the Japanese Government. TEPCO as a nuclear operator and NISA as a regulatory authority have also held press conferences on the status, details and development of the accident. NSC has provided important technical advice and explained about the evaluation of environment monitoring results and others at press conferences.

Joint press conferences participated by relevant organizations have been held since April 25 in order to share the same information. The Special Advisor to the Prime Minister, NISA, MEXT, Secretariat of NSC and TEPCO and other relevant organizations have participated in these joint press conferences.

As for inquiries from the general public, NISA has opened counseling hotline on the nuclear accident etc., and MEXT has also opened counseling hotline on the impact of radiation on health etc. Experts in academia including members of the Atomic Energy Society of Japan have actively explained and provided information to citizens.

Regarding provision of information to the international community, the Japanese Government has reported the accident status to the IAEA promptly pursuant to the Convention on Early Notification of a Nuclear Accident since the first report on 16:45 on March 11 right after the accident occurred. The Japanese Government has also reported the provisional evaluations of the International Nuclear and Radiological Event Scale (INES) when the government made an announcement on each evaluation.

As for opportunities for communication with countries across the world including neighboring countries, briefings to diplomats in Tokyo and press conferences for foreign media have been conducted.

Notification to other countries including neighboring countries about deliberate discharge of accumulated water of low-level radioactivity to the sea on April 4 was not satisfactory. We sincerely regretted and have made every effort to ensure sufficient communication with international community and reinforce the notification system.

Provisional evaluations of the INES are as follows:

(1) The first report

Provisional evaluation of Level 3 was issued based on the fact determined by NISA at 16:36 on March 11 that the emergency core cooling system for water injection became unusable. This situation occurred because motor operated pumps lost function due to entire power loss at Units 1 and 2 of Fukushima Dai-ichi NPS.

(3) The second report

On March 12, the PCV venting of the Unit 1 of Fukushima Dai-ichi NPS was conducted and an explosion at its reactor building occurred. Based on environmental monitoring, NISA confirmed the emission of radioactive iodine, cesium and other radioactive materials, and made announcement on the provisional evaluation of Level 4 because NISA determined that the emission of over 0.1 % of the radioactive materials in the reactor core inventory occurred.

(4) The third report

On March 18, as some incidents to cause fuel damage were identified at Units 2 and 3 of Fukushima Dai-ichi NPS, NISA announced the provisional evaluation of Level 5 because the release of several percent of the radioactive materials in the core inventory was determined to have occurred based on the information obtained at the moment including that of the status of Unit 1.

(5) The fourth report

On April 12, regarding the accumulated amount of the radioactive materials released in the atmosphere, NISA announced the estimates from analytical results of the reactor status etc and NSC announced the estimates from dust monitoring data. (Please refer to VI. 1) The estimation by NISA was 370,000 TBq of radioactivity in iodine equivalent and the calculated value based on the estimate of NSC was 630,000 TBq. Based on these results, NISA announced provisional evaluation of Level 7 on the same day. Although one month passed between the third and the fourth report, the provisional INES evaluation should have been made more promptly and appropriately.

10. Efforts to Restore the Accident in the Future

Regarding the current status of Fukushima Dai-ichi NPS, fresh water has been injected to RPV through a feed water system in Units 1, 2 and 3 and has been continuously cooling the fuel in the RPV. This has helped the temperature around the RPV stay around 100 to 120 degrees Celsius at the lower part of RPV. Review and preparation for circulation cooling system including the process of transferring and treating accumulated water has been underway. Although the RPV and PCV of Unit 1 have been pressurized to some extent, steam generated in some units such as Units 2 and 3 seems to have leaked from the RPV and PCV, which appears to have condensed to accumulations of water found in many places including reactor buildings and some steam seems to have been released to the atmosphere. To respond to this issue, the status has been checked by dust sampling in the upper part of the reactor buildings and discussion and preparation for covering the reactor buildings has been underway.

Cold shutdown of Units 5 and 6 has been maintained using residual heat removal systems with temporary seawater pumps and their reactor pressure has been stable in between 0.01 ~ 0.02 MPa (Gauge pressure).

Details of the current status of each unit are listed in the following chart.

(Megapascal: Unit of pressure 1 MPa = 9.9 atmosphere. Gauge pressure is absolute pressure minus atmospheric pressure.)
TEPCO announced the “Roadmap towards Restoration from the Accident in Fukushima Daiichi Nuclear Power Station” on April 17, and the following 2 steps as targets: "Radiation dose in steady decline" as "Step 1" and "Release of radioactive materials is under control and radiation

dose is being significantly held down" as "Step 2." The timeline for achieving targets are tentatively set as follows: "Step 1" is set at around 3 months and "Step 2" is set at around 3 to 6 months after achieving Step1.

Subsequently, coolant leakage from the PCVs was found in Units 1 and 2. Since the same risk was found in Unit 3, TEPCO announced the revised roadmap on May 17. In the new roadmap, basically no change was made in the schedule, but new efforts were added including reviewing and improving cooling reactors, adding measures against tsunami and aftershocks, and improving the work environment for workers.

Particularly in the review of the issues of “Reactor”, the establishment of a “circulation cooling system” in which contaminated water accumulated in buildings (accumulated water) etc. is processed and reused for water injection to reactors, was prioritized for “cold shutdown” in Step 2.

The NERHQs also presented the approach toward restoration and that related to evacuation area in the announcement, “Temporary approach policy for measures for nuclear sufferers,” on May 17.

11. Response in Other Nuclear Power Stations

On March 30, NISA instructed all electric power companies and related organizations to implement emergency safety measures at all NPSs, in order to prevent the occurrence of nuclear disasters and core damage, etc. caused by tsunami-triggered total AC power loss, on the basis of the latest knowledge gained from the accident in Fukushima NPS. On May 6, NISA carried out on-site inspections at all NPSs (except Onagawa NPS, Fukushima Dai-ichi and Fukushima Dai-ni NPS), and confirmed that emergency safety measures were appropriately implemented at these NPSs. On May 18, NISA received an implementation status report from Onagawa NPS, where work to prepare against tsunami was delayed after it was hit by the tsunami. Regarding Fukushima Dai-ni NPS, which achieved a stable condition after cold shutdown on April 21, NISA also instructed the NPS to implement emergency safety measures, and received an implementation status report from it on May 20. NISA confirmed that all the nuclear power stations in Japan have appropriately arranged measures against total AC power loss, etc. which are expected to be implemented immediately as emergency safety measures.

Based on presumed causes of the accident and the additional knowledge gained from the accident, which are stated in this report, and the lessons learned from the accident, which are mentioned in Section 12, NISA and other relevant ministries are to improve and strengthen the emergency safety measures that have been put in place. NISA will strictly verify the implementation status of enhanced measures by the nuclear operators and promptly come up with mid- and long-term measures.

The Headquarters for Earthquake Research Promotion of MEXT has estimated that there is an 87% percent chance of an imminent magnitude 8 earthquake in the Tokai region near the Hamaoka Nuclear Power Station of Chubu Electric Power Co., Inc. within the next 30 years. As this is accompanied with increasing concerns over the high possibility of a large-scale tsunami resulting from the envisioned earthquake, the government has placed its highest priority on public safety above all else, and considered that the operation of all Units at Hamaoka NPS should be halted until mid- to long-term countermeasures such as the construction of an embankment that can sufficiently withstand the envisioned Tokai Earthquake are implemented, and requested that Chubu Electric Power Co., Inc., should halt all reactors at the NPS on May 6. Chubu Electric Power Co., Inc. accepted this request and stopped operation of all the Units by May 14.

12. Lessons Learned from the Accident So Far

The accident of Fukushima NPS has the following aspects: it was triggered by a natural disaster; it led to a severe accident with damage to nuclear fuel, Reactor Pressure Vessels and Primary Containment Vessels; and accidents of multiple reactors were evoked at the same time. Moreover, as nearly three months have passed since the occurrence of the accident, a mid- to long-term initiative is needed to settle the situation imposing a large burden on the society such as a long-term evacuation of many residents in the vicinity and having a major impact on industrial activities including farming and livestock industries in the related area. There are thus many aspects different from the accidents in the past at Three Mile Island Nuclear Power Plant and Chernobyl Nuclear Power Plant.

The accident is also characterized by the following aspects. Emergency response activities had to be performed in a situation where the earthquake and tsunami destroyed the social infrastructure such as electricity supply, communication and transportation across a wide area in the vicinity. The occurrence of aftershocks frequently impeded various accident response activities.

This accident led to a severe accident, shook the trust of the public, and warned those engaged in nuclear energy of their overconfidence in nuclear safety.   It is therefore important to learn lessons thoroughly from this accident. We present the lessons classified into five categories at this moment bearing in mind that the most important basic principle in securing nuclear safety is defense in depth.

We present lessons that have been learned to date as classified in five categories. . We consider it inevitable to carry out a fundamental review on nuclear safety measures in Japan based on these lessons. Some of them are specific to Japan. However, we include these specific lessons from the standpoint to show the overall structure of lessons.

The lessons in category 1 are those learned based on the fact that this accident has been a severe accident, and from reviewing the sufficiency of preventive measures against a severe accident.

The lessons in category 2 are those learned from reviewing the adequacy of the responses to this severe accident.

The lessons in category 3 are those learned from reviewing the adequacy of the emergency responses to the nuclear disaster in this accident.

The lessons in category 4 are those learned from reviewing the robustness of the safety infrastructure established at the nuclear power station.

The lessons in category 5 are those learned from reviewing the thoroughness in safety culture while summing up all the lessons.

(Lessons in category 1) Strengthen preventive measures against a severe accident

(1) Strengthen measures against earthquakes and tsunamis

The earthquake was an extremely massive one caused by plurally linked seismic centers. As a result, in Fukushima Dai-ichi Nuclear Power Station, acceleration response spectra of seismic ground motion observed on the base mat exceeded the acceleration response spectra of the design basis seismic ground motion in a part of the periodic band. Although damage to external power supply was caused by the earthquake, no damage caused by the earthquake to systems, equipment and devices important for nuclear reactor safety at nuclear reactors has been confirmed. However, further investigation should be conducted as the detailed status remains unknown.

The tsunamis which hit Fukushima Dai-ichi Nuclear Power Station were 14-15m high, substantially exceeding the assumed height by the design of construction permit or subsequent evaluation. The tsunamis severely damaged seawater pumps, etc., causing failure to secure emergency diesel power supply and reactor cooling function. The procedural manual does not assume the flooding of tsunami but stipulates measures against a backrush. The assumption on the frequency and height of tsunamis was insufficient, and therefore, measures against large-scale tsunamis were not adequately prepared.

From the viewpoint of design, the range of an active period for a capable fault which needs to be considered in the seismic design for a nuclear power plant is considered within 120,000-130,000 years (50,000 years in the old guideline). The recurrence of large-scale earthquakes is expected to be appropriately considered. Moreover, residual risks are required to be considered. Compared with the design against earthquake, the design against tsunamis has been performed based on tsunami folklore and indelible traces of tsunami, not on the adequate consideration of the recurrence of large-scale earthquakes in relation to a safety goal to be attained.

Reflecting on the above issues, we will consider handling of plurally linked seismic centers as well as strengthening quake resistance of external power supply. Regarding tsunamis, from the viewpoint of preventing a severe accident, we will assume appropriate frequency and adequate height of tsunamis in consideration of a sufficient recurrence period for attaining a safety goal. Then, we will perform a safety design of structures, etc. to prevent the impact of flooding in the site caused by the adequately assumed high tsunamis in consideration of destructive power of tsunamis. While fully recognizing a possible risk caused by the flooding into buildings of tsunamis exceeding the ones assumed in design, we will take measures from the viewpoint of defense-in-depth, to sustain the important safety functions by considering flooded sites and the huge destructive power of run-up waves.

(2) Secure power supply

A major cause for this accident was a failure in securing the necessary power supply. This was caused by the facts that power supply sources were not diversified from the viewpoint of overcoming vulnerability related to failures derived from a common cause by an external event, and that the installed equipment such as a switchboard did not meet the specifications that could withstand a severe environment such as flooding. Moreover, it was caused by the facts that battery life was short compared with the time required for restoration of AC power supply and that a time goal required for the recovery of external power supply was not clear

Reflecting on the above facts, Japan will secure power supply at sites for a longer time determined as a goal even in severe circumstances of emergency through diversification of power supply sources by preparing various emergency power supply sources such as air-cooled diesel generators, gas turbine generators, etc., deploying power-supply cars and so on, as well as equipping switchboards, etc. with high environmental tolerance and generators for battery charge, and so on.

(3) Secure robust cooling functions of reactor and PCV

In this accident, the final place for release of heat (the final heat sink) was lost due to the loss of function of seawater pumps. Although the reactor cooling function of water injection was activated, core damage could not be prevented due to drain of water source for injection and loss of power supplies, etc., and PCV cooling function also did not run well. Thereafter the difficulties remained in reducing the reactor pressure and, moreover, in water injection after the pressure was reduced, because the water injection line into a reactor by the use of heavy machinery such as a fire engine, etc. had not been developed as a measure for accident management. In this manner, the loss of cooling functions of reactors and PCVs have aggravated the accident.

Reflecting on the above issues, Japan will secure robust alternative cooling functions of reactors and PCVs by securing alternative final heat sinks for a durable time. This will be pursued through such means as diversifying alternative water injection functions, diversifying and increasing sources for injection water, and introducing an air-cooling system.

(4) Secure robust cooling functions of spent fuel pools

In the accident, the loss of power supplies caused the failure to cool the spent fuel pools, requiring actions to prevent a severe accident due to the loss of cooling functions of spent fuel pools in parallel with responses to the accident of the reactors. So far, a risk of a major accident of a spent fuel pool had been deemed small compared with a core event and measures such as alternative water injection into a spent fuel pool, etc. were not considered.

Reflecting on the above issues, Japan will secure robust cooling measures by introducing alternative cooling functions such as a natural circulation cooling system or an air-cooling system, as well as alternative water injection functions in order to maintain cooling of spent fuel pools even in case of the loss of power supplies.

(5) Thorough accident management (AM) measures

The accident reached the level of so called a severe accident. The accident management measures had been introduced to Fukushima NPS to minimize the possibilities of severe accidents and to mitigate consequences in case of severe accidents. However, looking at the situation of the accident, although some part of the measures functioned, such as alternative water injection from the fire extinguishing water system to the reactor, the rest did not fulfill their roles in various responses including ensuring the power supplies and the reactor cooling function, and the measures turned out to be inadequate. In addition, the accident management measures are basically regarded as voluntary efforts by operators, not legal requirements, and so the development of these measures lacked strictness. Moreover, the guideline of accident management has not been reviewed since its development in 1992, and has not been strengthened or improved.

Reflecting on the above issues, we will change the accident management measures from the voluntary safety efforts of operators to legal requirements, and develop the accident management measures to prevent severe accidents, including the review of the design requirements as well, by utilizing a probabilistic safety assessment approach.

(6) Response to issues concerning the siting with more than one reactor

The accident occurred at more than one reactor at the same time, and the resources needed for accident response had to be dispersed. Moreover, as two reactors shared the facilities , the physical distance between the reactors was small and so on., the development of the accident occurred at one reactor affected the emergency responses at the nearby reactor.

Reflecting on the above issues, Japan will take measures to ensure that emergency operation at a reactor where an accident occurs can be conducted independently from operation at other reactors if one power station has more than one reactor. Also, Japan will assure the engineering independence of each reactor to prevent accident at one reactor from affecting nearby reactors. In addition, Japan will promote the development of a structure that enables each unit to carry out accident response independently, by choosing a responsible person for ensuring nuclear safety of each unit.

(7) Consideration on placements of NPS in basic design

Since the spent fuel storage pools were placed on the higher part of the reactor buildings, response to the accident became difficult. In addition, contaminated water from the reactor buildings reached the turbine buildings, which means that the spread of contaminated water to other buildings has not been prevented. .

Reflecting on the above issues, Japan will promote the adequate placement of facilities and buildings at the stage of basic design of placement of NPS, etc. in order to further ensure to conduct robust cooling, etc. and prevent expansion of impacts of the accident in consideration of occurrence of serious accidents. In this regard, as for existing facilities, additional response measures will be taken to add equivalent level of function to them.

(8) Ensuring the water tightness of essential equipment facilities

One of the causes of the accidents is that the tsunami flooded many essential equipment facilities including component cooling seawater pump facilities, the emergency diesel generators, switchboards, etc., impairing power supply and making it difficult to ensure cooling systems.

Reflecting on the above issues, in terms of achieving the target safety level, Japan will ensure the important safety functions even in case of tsunamis greater than ones expected by the design or floods hitting facilities located near rivers. In concrete terms, Japan will ensure the water-tightness of important equipment facilities by installing watertight doors in consideration of the destructive power of tsunami and flood, blocking flood route such as pipes, and the installation of drain pumps, etc.

(Lessons in Category 2) Enhancement of response measures against severe accidents

(9) Enhancement of prevention measures of hydrogen explosion

In the accident, an explosion probably caused by hydrogen occurred at the reactor building in Unit 1 at 15:36 on March 12, 2011, and at the reactor in Unit 3 at 11:01 on March 14 as well. In addition, an explosion that was probably caused by hydrogen occurred at the reactor building in

Unit 4 around 06:00 on March 15, 2011. While effective measures could not be taken from the first explosion, consecutive explosions occurred. These hydrogen explosions aggravated the accident. A BWR inactivates a PCV and has a flammability control system in order to maintain the soundness of a PCV against design basis accidents. However, it was not assumed that an explosion in reactor buildings would be caused by hydrogen leakage, and as a matter of course, hydrogen measures for reactor buildings were not taken.

Reflecting on the above issues, we will enhance measures for preventing a hydrogen explosion such as the installation of a flammability control system to function in the event of a severe accident in reactor buildings, for the purpose of discharging or reducing hydrogen in reactor buildings, in addition to a hydrogen measures in a PCV.

(10) Enhancement of containment venting system

In the accident, there were problems in operability of the containment venting system in the face of severe accident. Also, as the function of removing released radioactive material in the containment venting system was insufficient, therefore, the system was not effective as accident management measures. In addition, the independence of the vent line was insufficient and it may have had an adverse effect on other parts through connecting pipes, etc.

Reflecting on the above issues, we will enhance a containment venting system by improving its operability, ensuring the independence, and strengthening the function of removing released radioactive material.

(11) Improvement of accident response environment

In the accident, the radiation dosage increased in the main control room and operators could not enter the room temporarily and the habitability in the main control room has decreased. It still remains difficult to work in the room for an extended period. Moreover, at the on-site emergency station, a control tower of all emergency measures on the site, the accident response activities were affected by the increase of radiation dosage and worsening of the communication environment and lighting.

Reflecting on the above issues, we will enhance the accident response environment that enables continued accident response activities even in case of severe accidents through measures such as strengthening radiation shielding in the control rooms and the emergency centers, enhancing the exclusive ventilation and air conditioning system on site, as well as strengthening related equipment including communication and lightening systems without use of AC power supply.

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

In the accidents, although adequate radiation management became difficult as many of the personal dosimeters and dose reading devices became unusable due to submergence in seawater, personnel engaged in radiation work had to work on site. In addition, measurements of concentration of radioactive material in air were delayed, and as a result the risk of internal exposure increased.

Reflecting on the above issues, we will enhance the radiation exposure management system at accident by storing the adequate amount of personal dosimeters and protection suits and gears for accident, developing the system in which radioactive management personnel can be expanded at accident and improving the structure and equipment to measure radiation dose of radiation workers promptly.

(13) Enhancement of training responding to severe accident

Effective training to respond to accident restoration at nuclear power plants and adequately work and communicate with relevant organizations in the wake of severe accidents was not sufficiently implemented up to now. For example, it took time to establish communication between the emergency office inside of the power station, the Nuclear Emergency Response Headquarters and the Local Headquarters and also to build a collaborative structure with the Self Defense Forces, the Police, Fire Authorities and other organizations which played important roles in responding to the accident. Adequate training could have prevented these problems in advance.

Reflecting on the above issues, we will enhance training to respond to severe accidents by promptly building a structure for responding to accident restoration, identifying situations within and outside power plants, facilitating the gathering of human resources needed for securing the safety of residents and effectively collaborating with relevant organizations.

(14) Enhancement of instrumentation to identify the status of reactors and PCVs

Because the instrumentation of reactors and PCVs did not function sufficiently during the

severe accident, it was difficult to promptly and adequately obtain important information to identify the development of the accident such as the water levels and the pressure of reactors, and the source and amount of released radioactive materials.
In respond to the above issues, we will enhance the instrumentation of reactors and PCVs, etc. to enable it to effectively function even in the wake of severe accidents.

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

Logistic support has been diligently provided by those responding to the accident and supporting affected people with supplies and equipment gathered mainly at J Village. However, because of the damage from the earthquake and tsunami in the surrounding areas shortly after the accident, we could not promptly and sufficiently mobilize rescue teams to help provide emergency supplies and equipment and support accident control activities. This is why the on-site accident response did not sufficiently function.

Reflecting on the above issues, we will introduce systems for centrally controlling emergency supplies and equipment and setting up rescue teams for operating such system in order to provide emergency support smoothly even under harsh circumstances.

(Lessons in Category 3) Enhancement of nuclear emergency response

(16) Response to combined emergency of both large-scale natural disaster and prolonged nuclear accident

We had tremendous difficulty in communication and telecommunications, mobilizing human resources, procuring supplies and others when addressing the nuclear accident that coincided with a massive natural disaster. As the nuclear accident has been prolonged, some measures such as evacuation of residents, which was originally assumed to be a short-term measure, have been forced to be extended.

Reflecting on the above issues, we will prepare a structure and an environment where appropriate communication tools and devices and channels to procure supplies and equipment will be ensured in coincidental combined emergency of both massive natural disaster and prolonged nuclear accident. Also, assuming a prolonged nuclear accident, we will enhance emergency response preparedness including effective mobilization plans to gather human resources in various fields who are involved with the accident response and sufferers support.

(17) Reinforcement of environment monitoring

Currently, local governments are responsible for environmental monitoring in an emergency. However, appropriate environmental monitoring was not possible immediately after the accident because equipment and facilities for environmental monitoring owned by local governments were damaged by the earthquake and tsunami and the relevant individuals had to evacuate from the Off-site Center Emergency Response Center. To make up for this, MEXT has conducted environmental monitoring in cooperation with relevant organization.

Reflecting on the above issues, the Government will develop a structure where the Government will implement environmental monitoring in a reliable and well-planned manner in emergency.

(18) Establishment of clear division of labor between relevant central and local organizations

Communication between local and central offices as well as with other organizations was not sufficiently achieved due to lack of communication tools immediately after the accident and also roles and responsibilities of each side were not clearly defined. Specifically speaking, responsibility and authority were not clearly defined in the relationship between the NERHQs Nuclear Emergency Response Headquarters and Local NERHQs Headquarters, between the Government and TEPCO, between the Head Office of TEPCO and NPS on site, as well as among the relevant organizations in the Government. Especially, communication was not sufficient between the government and the main office of TEPCO at the initial point of the accident.

Reflecting on the above issues, we will review and define roles and responsibilities of relevant organizations including the NERHQs, clearly specify roles, responsibilities and tools in their communication and improve institutional mechanisms.

(19) Enhancement of communication relevant to the accident

Communication to residents in the surrounding area was difficult because communication tools were damaged by the large-scale earthquake. The subsequent information to residents in the surrounding area and local governments was not always provided in a timely manner. The impact of radioactive materials on health and the radiological protection guideline of the ICRP, which are the most important information for residents in the surrounding area and others, were not sufficiently explained. We have focused on publicizing mainly accurate facts to the citizens and have not sufficiently present future outlook on risk factors, which sometimes gave rise to concerns about future prospects.

Reflecting on the above issues, we will reinforce adequate provision of information on the accident status and response and appropriate explanation about the radiation effect to the residents in the vicinity. Also, we will keep in mind that the future outlook on risk factors is included in the information delivered while incidents are ongoing status.

(20) Enhancement of response to assistance by other countries and communication to the international community

The Japanese Government could not appropriately respond to the assistance offered by other countries across the world because there was not a specific structure in the Government to accommodate such assistance offered by other countries with the domestic needs. Communication with the international community including prior notification to neighboring countries and areas on the discharge of water with low-level radioactivity to the sea was not always sufficient.

Reflecting on the above-mentioned issues, the Japanese Government will contribute to developing a global structure for effective response, by cooperating with the international community, for example, developing a list of supplies and equipment for effective response to any accident; specifying contact points of each country in advance in case of accident; and enhancing information sharing framework through improvement of international notification system; providing faster and more accurate information, which makes it possible to take measures based upon scientific evidence.

(21) Adequate identification and forecast of the effect of released radioactive materials

The system for Prediction of Environmental Emergency Dose Information (SPEEDI) could not make proper prediction on the effect of radioactive materials as originally designed, due to the lack of information on the release source. Even under such restricted conditions, it should have been utilized, as a reference of evacuation activities and other purposes by presuming diffusion trend of radioactive materials under a certain assumption. Although the results generated by SPEEDI are now being disclosed, it should have been done so from the initial stage.

The Japanese Government will improve the instrumentation and facilities to ensure release source information can be securely obtained. Also, it will develop a plan to effectively utilize SPEEDI and other systems to address various emergency cases and disclose the data and results from SPEEDI, etc. from the beginning of these cases.

(22) Clear definition of widespread evacuation area and radiological protection guideline in nuclear emergency

Immediately after the accident, Evacuation Area and In-house Evacuation Area were established, and cooperation of residents in the vicinity, local governments, police and relevant organizations facilitated the fast implementation of evacuation and “Stay In-house” instruction. As the accident prolonged, the residents had to be evacuated or stay in-houses for a long period. Subsequently, however, guidelines of ICRP and IAEA, which have not been used before the accident, were decided to be used when establishing Deliberate Evacuation Area and Emergency Evacuation Prepared Area. The size of the protection area defined after the accident was considerably larger than 8 to 10 km radius from the NPS, which was defined as the area where focused protection measures should be taken.
Based on the experience gained in the accident, the Japanese Government will make much more efforts to clearly define the evacuation areas and guidelines of radiological protection in nuclear emergency.

（Lessons in Category4) Reinforcement of safety infrastructure

(23) Reinforcement of safety regulatory bodies

Governmental organizations have different responsibilities for securing nuclear safety. For example, NISA of METI is responsible for safety regulation as a primary regulatory body, the Nuclear Safety Commission of the Cabinet Office is responsible for regulation monitoring of the primary governmental body, and relevant local governments and ministries are in charge of emergency environmental monitoring. This is why it was not clear who has the primary responsibility for ensuring citizens’ safety in an emergency. Also, we cannot deny that the existing organizations and structures made mobilization of capabilities difficult to promptly respond to such a large-scale nuclear accident.

Reflecting on the above issues, the Japanese Government will separate NISA from METI, and starting to review implementing frameworks, including NSC and relevant ministries, for administration on nuclear safety regulation and for environmental monitoring.

(24) Establishment and reinforcement of legal structure, criteria and guidelines

Reflecting on this accident, various challenges are identified regarding the establishment and reinforcement of legal structures on nuclear safety and nuclear emergency preparedness and response, and related criteria and guidelines. Also, based on the experiences of this nuclear accident, many issues would be identified as ones to be reflected in the standards and guidelines of IAEA.

Therefore, the Japanese Government will review and improve the legal structures of nuclear safety and nuclear emergency preparedness and response, and related criteria and guidelines. During this process, it will reevaluate measures taken against age-related degradation of the existing facilities, from the viewpoint of structural reliability as well as necessity for responding to new knowledge and expertise including the progress of system concepts. Also, the Japanese Government will clarify technical requirements based on new laws and regulations, and new findings and knowledge for facilities already approved and licensed, in other words, the status of back-retrofitting under laws and regulations. The Japanese Government will make every effort to contribute to improving safety standards and guidelines of the IAEA by providing related data.

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

All the experts on severe accidents, nuclear safety, nuclear emergency preparedness and response, risk management and radiation medicine should get together to address such an accident by making use of the latest and best knowledge and experience. Also, it is extremely important to develop human resources in the fields of nuclear safety and nuclear emergency preparedness and response in order to ensure mid-and-long term efforts on nuclear safety as well as to restore from the current accident.

Reflecting on the above-mentioned issues, the Japanese Government will enhance human resource development in the activities of nuclear operators and regulatory organizations along with focusing on education of nuclear safety, nuclear emergency preparedness and response, crisis management and radiation medicine at educational organizations.

(26) Securing independency and diversity of safety system

Although multiplicity was valued in order to ensure reliability of safety systems so far, avoidance of common cause failures has not been carefully considered and independency and diversity have not been sufficiently secured.

Therefore, the Japanese Government will ensure the independency and diversity of safety systems so that common cause failures can be adequately addressed and the reliability of safety functions can be further improved.

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

PSA has not always been effectively utilized in the overall reviewing processes and efforts of risk reduction at nuclear power plants. While quantitative evaluation of risks of quite rare events such as large-scale tsunami is difficult and may be associated with uncertainty even in PSA, we have not made sufficient efforts to improve reliability of the assessment by explicitly identifying such uncertainty of the risks.

Considering knowledge and experiences of uncertainties, the Japanese Government will further actively and swiftly utilize PSA and developing improvement of safety measures including effective accident management measures based on PSA.

(Lessons in Category 5) Raise awareness of safety culture

(28) Raise awareness of safety culture

All those involved with nuclear energy should be equipped with a safety culture. “Nuclear safety culture” is stated as “A safety culture that governs the attitudes and behavior in relation to safety of all organizations and individuals concerned must be integrated in the management system.” (IAEA, Fundamental Safety Principles, SF-1, 3.13) Learning this message and putting it into practice is the starting point, duty and responsibility of those who are involved with nuclear energy. Without a safety culture, there will be no constant improvement of nuclear safety.

Reflecting on the current accident, the nuclear operators whose organization and individuals have primary responsibility for securing safety should look at every knowledge and findings, and make sure whether or not they indicate the vulnerability of a plant. They should reflect as to whether they have been serious in introducing appropriate measures for improving safety, when they are not confident that risks concerning public safety of the plant remain low.

Also, organizations or individuals involved in national nuclear regulations, as ones responsible for ensuring nuclear safety for the people, should reflect whether they have been serious in addressing new knowledge in a responsive and prompt manner, not leaving any doubt in terms of safety.

Reflecting on this viewpoint, we will establish safety culture, by going back to the basics that pursuing defense-in-depth is essential for ensuring nuclear safety, constantly learning professional knowledge on safety, and maintaining an attitude for trying to identify weaknesses as well as rooms for improvement for safety.

13. Conclusion

The nuclear accident that occurred in Fukushima Nuclear Power Station (NPS) on March 11, 2011 was caused by an extremely massive earthquake and tsunami rarely seen in history, and resulted in an unprecedented serious accident that extended over multiple reactors simultaneously. Japan is extending its utmost efforts to confront and overcome this difficult accident.

In particular, at the accident site, people engaged in the work have been making every effort under severe conditions for the restoration from the accident. It is impossible to resolve the situation without these contributions. The Japanese Government is determined to make its utmost effort to support the people engaged in the work.

We are taking very seriously the fact that the accident, triggered by a natural disaster of an earthquake and tsunami, became a severe accident due to such causes as the losses of power and cooling functions, and that consistent preparation for severe accidents was insufficient. In light of the lessons learned from the accident, Japan has recognized that a fundamental revision of its nuclear safety preparedness and response is inevitable.

As a part of this effort, Japan will promote the “Plan to Enhance the Research on Nuclear Safety Infrastructure” while watching the status of the process of restoration from the accident. This plan is intended to promote, among other things, research to enhance preparedness and response against severe accidents through international cooperation, and to work to lead the results achieved for the improvement of global nuclear safety.

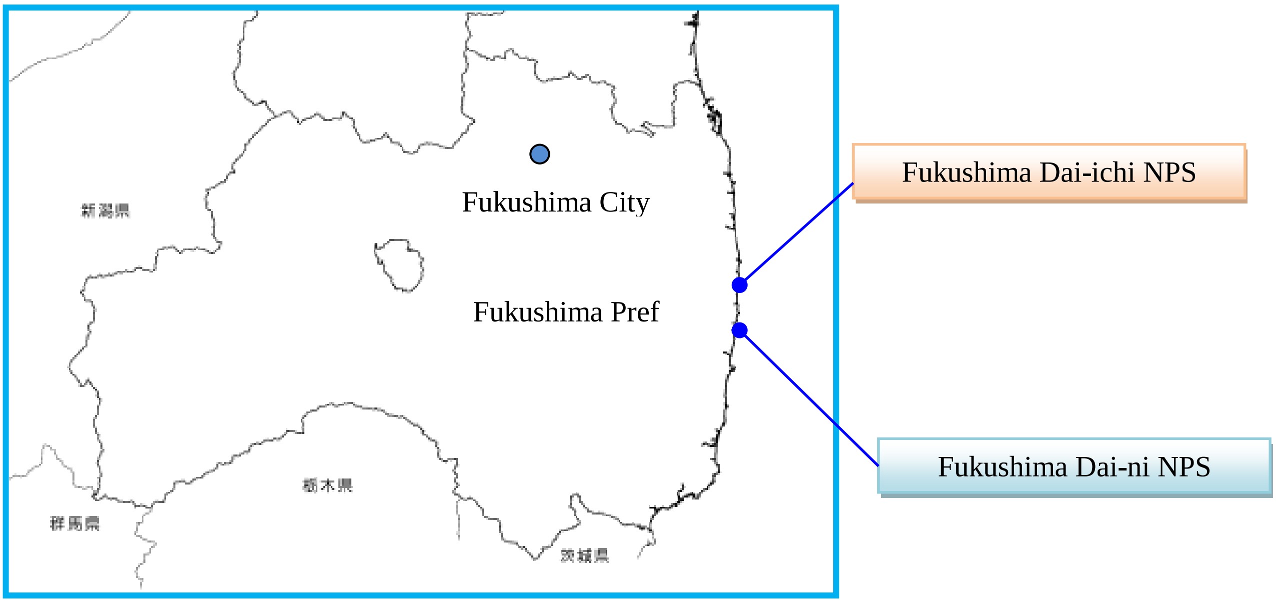
At the same time, it is necessary for Japan to conduct national discussions on whole concept of the nuclear power generation while disclosing actual costs of nuclear power generation including for securing safety.

Japan will update information on the accident and lessons learned from it in line with the future process of restoration from the accident and with further investigation and will continue to provide such information and lessons learned to the International Atomic Energy Agency as well as countries around the world.

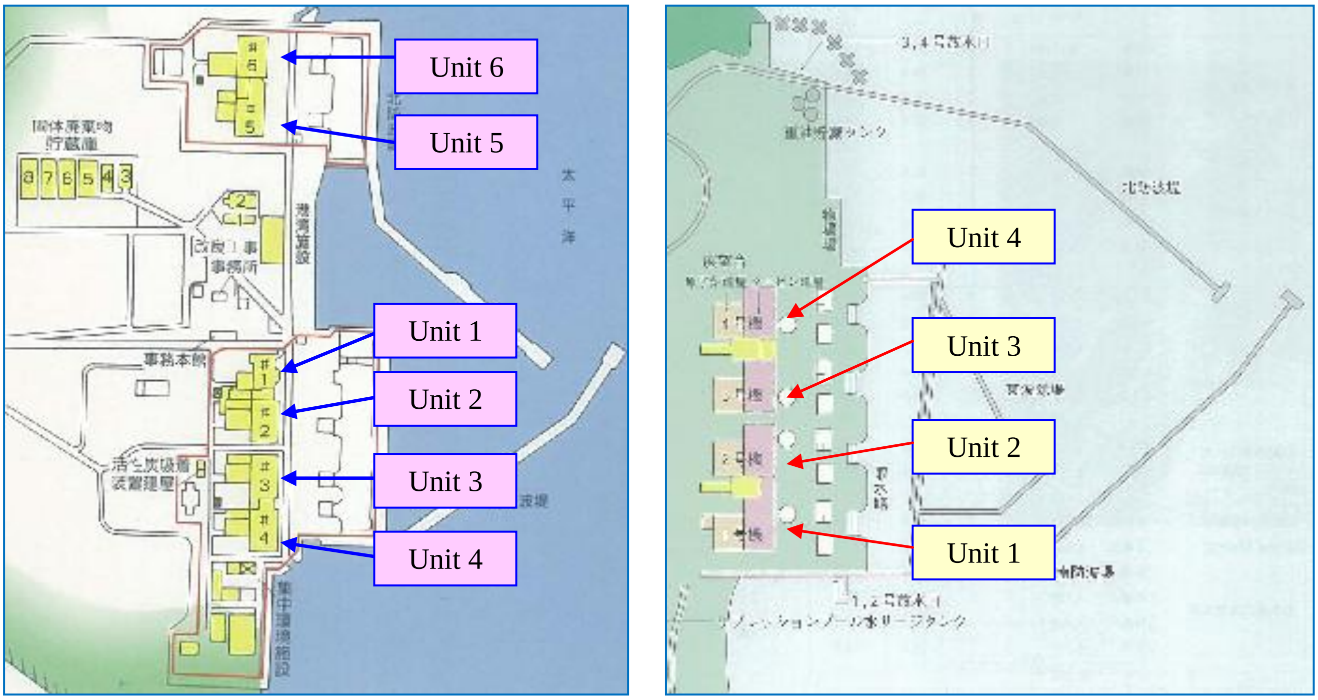
Moreover, we feel encouraged by the support towards restoration from the accident received from many countries around the world to which we express our deepest gratitude, and we would sincerely appreciate continued support from the IAEA and countries around the world.

We are prepared to confront much difficulty towards restoration from the accident, and also confident that we will be able to overcome this accident by uniting the wisdom and efforts of not only Japan, but also the world.

Location of NPSs in Tohoku area



Location of Fukushima NPS



Layout of Fukushima Dai-ichi NPS and Fukushima Dai-ni NPS

Generation Facilities of Fukushima Dai-ichi NPS

	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6
Electric Output (MWe)	460	784	784	784	784	1100
Commercial Operation	1971/3	1974/7	1976/3	1978/10	1978/4	1979/10
Reactor Model	BWR3	BWR4			BWR5	
PCV Model	Mark-1					Mark-2
Number of Fuel Assembly in the Core	400	548	548	548	548	764

Generation Facilities of Fukushima Dai-ni NPS

	Unit 1	Unit 2	Unit 3	Unit 4
Electric Output (MWe)	1100	1100	1100	1100
Commercial Operation	1982/4	1984/2	1985/6	1987/8
Reactor Model	BWR5			
PCV Model	Mark-2	Mark-2 Advance		
Number of Fuel Assembly in the Core	764	764	764	764

Status of Each Unit of Fukushima Dai-ichi NPS (As of May 31)

Unit No.	Unit 1	Unit 2	Unit 3	Unit 5	Unit 6
Situation of water injection to reactor	Injecting fresh water via the Water Supply Line. Flow rate of injected water : 6.0 m^3/h	Injecting fresh water via the Fire Extinguish and Water Supply Line. Flow rate of injected water: 7.0m^3/h(via the Fire Protection Line), 5.0m^3/h(via the Feedwater Line)	Injecting fresh water via the Water Supply Line. Flow rate of injected water : 13.5 m^3/h	Water injection is unnecessary as cooling function of the reactor cores are in normal operation.	
Reactor water level	Fuel range A : Off scale Fuel range B : -1,600mm	Fuel range A : -1,500mm Fuel range B : -2,150mm	Fuel range A:-1,850mm Fuel range B:-1,950mm	Shut down range measure ment 2,164mm	Shut down range measure ment 1,904mm
Reactor pressure	0.555MPa g(A) 1.508MPa g(B)	-0.011MPa g (A) -0.016MPa g (B)	-0.132MPa g (A) -0.108MPa g (B)	0.023 MPa g	0.010 MPa g
Reactor water temperature	(Collection impossible due to low system flow rate)			83.0°C	24.6°C
Temperature related to Reactor Pressure Vessel (RPV)	Feedwater nozzle temperature: 114.1°C Temperature at the bottom head of RPV: 96.8°C	Feedwater nozzle temperature: 111.5°C Temperature at the bottom head of RPV: 110.6°C	Feedwater nozzle temperature: 120.9°C Temperature at the bottom head of RPV: 123.2°C	(Monitoring water temperature in the reactor.)	
D/W Pressure, S/C Pressure	D/W: 0.1317 MPa abs S/C: 0.100 MPa abs	D/W: 0.030 MPa abs S/C: Off scale	D/W: 0.0999 Mpa abs S/C: 0.1855 MPa abs	-	
Status	We are working on ensuring the reliability of cooling function by installing temporary emergency diesel generators and sea water pumps as well as receiving electricity from the external power supplies in each plant.				