Additional Report of the Japanese Government to the IAEA

- The Accident at TEPCO's Fukushima Nuclear Power Stations -

(Second Report)

(Summary)

September 2011

Nuclear Emergency Response Headquarters

Government of Japan

Contents of Summary

1.Introduction

The Nuclear Emergency Response Headquarters of the Government of Japan prepared for the International Atomic Energy Agency (IAEA) Ministerial Conference on Nuclear Safety convened in June 2011 a report (hereinafter referred to as the "June Report") addressing the situation of the accident at the Tokyo Electric Power Company' (TEPCO) Fukushima Nuclear Power Stations which occurred on March 11 of this year. This report covered the occurrence and development of the accident, responses to the nuclear emergency, lessons learned from the accident until that time, and other such matters. The Headquarters submitted the report to the IAEA and made presentations of the report at the Conference.

The Ministerial Declaration and the Chair's Summary of the Conference's plenary session state expectations towards Japan for the continued provision of information. The government recognizes that it is incumbent upon Japan to continue to provide accurate information regarding the accident to the international community, including lessons learned through the accident. In accordance with this approach the Government of Japan decided to compile information on the state of affairs subsequent to the June report in the form of an additional report and submit it to the IAEA on the occasions of the Board of Governors meeting and the General Conference.

Restoration from the accident has been steadily proceeding with Step 2 after completing Step 1, including among other matters the achievement of stable cooling of the nuclear reactors and the spent fuel pools in Fukushima NPS. That said, the situation is such that several more months are expected to be required to bring about more stable cooling. Against such a backdrop, the following three points have been noted in preparation of this additional report.

(1) This report compiles additional information on the accident obtained as well as efforts being made to bring about restoration from the accident after the June Report.
(2) The report compiles the current state of efforts to make full use of lessons learned.
(3) The report indicates of the state of affairs regarding the response to those who have suffered as a result of the nuclear accident (an off-site response) and the state of examination of a mid- to long-term plan for the site after restoration from the accident is completed (an on-site plan).

Particularly with regard to (3) above, the Government of Japan not only naturally advances its own initiatives but also considers it to be of paramount importance in the context of steadily advancing the initiatives to undertake matters through obtaining information, such as the related experiences and research results of other nations around the world and international organizations, as well as through receiving technical cooperation with them. Japan hopes this report will serve to engender such partnerships.

This additional report records in considerable detail what has been ascertained up until the present time regarding the situation of the responses at not only the Fukushima NPS but also other NPSs affected by the Tohoku District - Off the Pacific Coast Earthquake and the subsequent tsunamis. Moreover, the report gives an account of developments in terms of the response to those suffering as a result of the nuclear accident, including decontamination efforts. On the other hand, efforts regarding nuclear damage compensation are not covered, as was also the case with the June Report.

Preparation of this additional report has been carried out in the Government Nuclear Emergency Response Headquarters, taking into consideration efforts for restoration from the accident conducted by the Government-TEPCO Integrated Response Office, while also listening to opinions from outside eminent persons. The work in preparing this report has been managed as a whole by Mr. Goshi Hosono, Minister for the Restoration from and Prevention of Nuclear Accidents, and compiled with Mr. Yasuhiro Sonoda, Parliamentary Secretary of the Cabinet Office, playing a central role.

Japan's basic policy is to maintain a high degree of transparency as it releases information about the accident. Consequently in this report as well, it has paid attention to providing accurate descriptions of the facts of the situation while also evaluating as stringently and objectively as possible its countermeasures to address the accident. Hearings were also conducted with related parties as necessary in order to confirm various situations. The descriptions of factual situations are based on what had been ascertained as of August 31.

Japan will continue to make full use of appropriate opportunities to disseminate additional reports to the world about the accident, using a similar format. In addition, with the activities of the "Investigation Committee on the Accidents at the Fukushima Nuclear Power Station of Tokyo Electric Power Company" established by the government now fully underway, the results of the Committee's investigation will also be publicly disclosed to the world in the course of time.

Japan intends to engage in efforts for restoration from this accident in partnership with the world. It will at the same time firmly uphold the principle of transparency as it continues to provide information about the state of affairs regarding the accident to the world through the IAEA.

2. Further Developments regarding the Nuclear Accident

(1) The Tohoku District-Off the Pacific Ocean Earthquake and the resulting tsunamis

A seismic source rupture process (a seismic source model) and a tsunami source rupture process (a tsunami source model) were obtained through an analysis that used observed ground motion data and observed tsunami waveform data, respectively. The results of this analysis indicated that slips, which are one of the major factors in mechanisms that give rise to seismic and tsunami sources, were between 55 m and not quite 70 m in the shallow area along the Japan Trench.

There is a high probability that the recent earthquake was an earthquake of M9 in terms of long-period ground motions, yet had at the same time characteristics of an earthquake of M8 in terms of short-period ground motions.

It is likely that those factors that had a great impact on the tsunami water level include the large slip noted above and the overlap effects of the tsunami water level due to a delay in rupture start time associated with consecutive rupturing of multiple seismic source areas.

(2) Status of the accident at the Fukushima NPSs, etc.

TEPCO has reported that, in an effort to ascertain the inundation height and inundation area of the premises of the Fukushima Dai-ichi NPS on the basis of tsunami source models estimated through figure simulation, it was successful in reproducing the actual behavior for the most part. TEPCO also reported investigation results which included that the direct main bus panels of Units 1, 2 and 4 were inundated due to the tsunamis while those of Units 3, 5 and 6 were spared, and that the inundation pathway leading to the main buildings was mainly the opening on the ground on the sea side of the turbine building and the opening connecting to the trench duct under the ground.

TEPCO has also reported the results of an evaluation analyzing the impacts of earthquakes on buildings and structures as well as equipment and piping critical to safety, stating that it can be estimated that the major facilities and equipment that had key functions with regard to safety were, at the time of the earthquake and immediately afterwards, at a status at which safety functions could be maintained. Insofar as many aspects regarding the detailed status of impacts caused by the earthquake remain unclear, the Nuclear and Industrial Safety Agency intends to conduct further investigations and examination, such as through a substantial on-site investigation, and also carry out evaluations.

The Nuclear and Industrial Safety Agency has received reports from TEPCO regarding the accident and has been moving forward with investigations making use of hearings with the employees of TEPCO and others. Based on these, the major additional information regarding the status of the initial response at the power stations after the accident occurred with regard to such matters as cooling, alternative water injection, the

PCV venting, and so on, as well as the current state of affairs including the state of the spent fuel pools, the state of the RPV, and the like were determined to be as follows.

1) The status of the Fukushima Dai-ichi NPS in overall terms

In the Fukushima Dai-ichi NPS after the earthquake struck, while the staff designated for emergency responses was able to be secured, these persons were required to carry out various responses to the situation of concurrent disasters at multiple Units. As a result of the lost of all AC power supply due to the tsunami striking, the means of communication within the power station were extremely limited, including the loss of function of the site-specific PHS system. The Safety Parameter Display System (SPDS), which is the system to figure out the status of each plant, lost its ability to function, negatively impacting the formulation of response measures within the power station’s emergency response headquarters.

On the basis of the state of damage of its power supply facilities, TEPCO had power supply vehicles from all of its branches head to the Fukushima Dai-ichi NPS beginning on the evening on March 11, but due to road damage and traffic jams, they were not able to proceed as intended. The transportation by air of power supply vehicles by the Self-Defense Forces was also considered but this could not be realized due to the great weight of the vehicles. It was against such a backdrop that, utilizing power supply vehicles secured before dawn on March 12, the staff of the stations undertook work to lay electricity cables with a view to restoring power supply amidst extremely poor working surroundings, such as darkness, strong aftershocks occurring intermittently, an ongoing major tsunami alert, pools of water left by the tsunamis, obstacles strewn about, the high air dose, etc.

2) Unit 1 of Fukushima Dai-ichi NPS

- *Initial cooling*

Although cooling by isolation condenser (IC) (two lines) was begun after the automatic shutdown of the nuclear rector, it was manually stopped by following the operation procedure documents because of a rapid decrease in the temperature of the RPV. After that, using only one system of IC, start-up and shutdown was repeated manually. The loss of power supplies due to the following tsunami made it impossible to confirm the operating status of the IC.

- *Alternate water injection*

Since it was unclear whether the IC functions at the plant were able to be maintained and since it was impossible to confirm the water level of the reactors, at 17:12 on March 11, with the aim of implementing cooling by means of alternative water injection, TEPCO started to consider adopting alternative water injection actions (the fire protection system, the make-up water condensate system) set up as accident management (AM) measures and fire engines using fire cisterns, which had been set up in response to the lessons learned from the Niigata-ken Chuetsu-oki Earthquake. Regarding the utilization of the fire protection system, staff manually opened valves of the core spray system and so on in the dark, making it possible for water injection to occur after the depressurization of the RPV.

Also, although the deployment of an available fire engine near Unit 1 became necessary, tsunami-induced driftage interrupted the flow of road traffic on site. A fire engine was deployed near Unit 1 only after securing an access route by breaking the lock of a gate that was closed. It was through such difficult work that at 05:46, March 12, fresh water injection was started using the fire engine, by means of the fire protection system line.

- *PCV venting*

Because the means to transfer heat to the ultimate heat sink was lost as a result of the tsunami, TEPCO started to review from the very earliest stages of the accident the possibility of conducting PCV venting. When station employees connected a small generator at around 23:50 on March 11 to the instrument to confirm PCV drywell pressure, it was 0.600 MPa abs (maximum operating pressure is 0.427 MPa gage (= 0.528 MPa abs)). Therefore the NPS started work in concrete terms to perform venting. The evacuation of residents in the vicinity was being confirmed prior to performing the venting, and at 9:03 on March 12 the evacuation of Okuma Town (Kuma district) was confirmed as having been completed. At around 9:15 station employees performed the operation to open a PCV venting valve (open 25% of the stipulated procedure) using the light of a flashlight in the darkness. Subsequently station employees went to operate the small valve of the suppression chamber (S/C); but, it was impossible to do so due to a high dose in the environment of that spot. Due to this, the opening operation of the S/C small valve in the Main Control Room was performed with expectations of residual pressure of air in the S/C small valve, and the operation to open the S/C large valve through the use of a temporary compressor was performed at around 14:00 that day. The result was that at 14:30 the PCV drywell pressure was confirmed to have decreased, and consequently it was judged that venting had been performed.

- *Situation of the spent fuel pool*

Due to the loss of all AC power and the consequent loss of seawater pump function due to the earthquake and tsunamis on March 11, the functions of cooling and of make-up water were lost. The reactor buildings were damaged by hydrogen explosions on March 12 and portions of the ceilings fell down on the upper side of the pool. There is a high probability that exposed fuel was avoided by maintaining the water level at the spent fuel pool through the spraying of water by concrete pump truck and injections of water taken from the piping of the fuel pool cooling and cleanup systems and freshwater sources. An alternative cooling system has been organized and operated since August 10 and at present the water temperature has been stabilized at approximately 30^{o}C.

- *Current status of the RPV*

As of August 31, water injection was being undertaken at a flow rate of approximately 3.6m^3/h, which exceeds the flow rate equivalent to decay heat. The temperature of the bottom of the RPV is below 100^{o}C and has been trending in a stable manner without showing any continuous increasing trend for the past month, a fact indicating that sufficient cooling has been secured through the circulating water injection cooling system. The injection of nitrogen into the PCV has been underway since starting the injection on April 7.

3) Unit 2 of Fukushima Dai-ichi NPS

- *Initial cooling*

Although the loss of power supplies due to the tsunamis made the operating status of the reactor core isolation cooling system (RCIC) unidentifiable, at 02:55, March 12, it was confirmed that the RCIC was in operation, and thereafter, the monitoring of the reactor continued for a little while as an alternative water injection system was prepared.

- *Alternative water injection*

Since it was impossible to determine whether or not the RCIC function was being maintained immediately after the tsunamis struck, just as with Unit 1, TEPCO began to consider adopting alternative water injection actions (the fire protection system, the make-up water condensate system) which had been set up as AM measures, as well as fire engines using the fire cistern. Thereafter, upon confirming the operation of the RCIC, monitoring of the reactor condition continued for some time, and in parallel, a water injection line which took its water from the Unit 3 backwash valve pit was developed in case the RCIC stopped, and hoses were connected the fire engines deployed. At 11:01, March 14, an explosion occurred in the rector building of Unit 3, resulting in the water injection line which had been ready for operation becoming unusable due to damages to the fire engines and hoses. At 13:25 on the same day, since it was judged that the operation of RCIC was not available, it was decided that due to the fact that debris lay scattered on the site direct seawater injection from the landing area would be implemented. After that, while the work was forced to stop due to aftershock, the subsequent arrangements including, among others, reconnecting hoses, depressurizing the RPV using main steam safety relief valves (SRV), and refueling fire engines which had stopped operations after running out of fuel, were completed, although some interruption by aftershocks were unavoidable. At 19:54 on the same day, TEPCO began seawater injections via fire engines.

- *PCV venting*

In order to create a situation in which PCV venting can be performed, operations to open a PCV vent valve (MO valve (motor operated valve)) (open 25% of the stipulated procedure) was performed at 8:10 on the 13th, and the operation of opening the large valve of the S/C vent (AO valve (air operated valve)) was performed at 11:00 of the same day to complete the vent line configuration and await the blowout of a rupture disk. However, after that, the S/C large valve was closed and unable to be re-opened, affected by the explosion of the reactor building of Unit 3 at 11:01 on the 14th; nevertheless, efforts were continued to form a line. At around 21:00 on that day the small valve of the S/C vent (AO valve) was opened slightly, making the vent line configuration successful again. However, a policy of drywell venting was adopted because the pressure on the S/C side was lower than the working pressure of the rupture disk and the pressure on the drywell side was increasing, and an operation to open the small valve of the drywell vent valve (AO valve) was performed once at 0:02 on the 15th; however, it was confirmed several minutes later that the small valve was closed. After that, drywell pressure maintained a high level of values; large sounds of impact occurred between around 6:00 and 6:10 of the 15th, while S/C pressure indicated 0 MPa abs. Lower drywell pressure was also confirmed at around 11:25 on that day.

- *Situation of the spent fuel pool*

Due to the loss of all AC power and the consequent loss of the seawater pump function due to the earthquake and tsunamis on March 11, the functions of cooling and of make-up water was lost. A blow-out panel of the reactor building at Unit 2 was thrown open by a hydrogen explosion at the reactor building of Unit 1 on March 12. Water injections using seawater as the source water and which made use of the piping of the fuel pool cooling and cleanup system had started since March 20. (This was switched to a freshwater source as of March 29.) There is high probability that exposed fuel has been avoided by maintaining the water level of the spent fuel pool through this method of water injection. An alternative cooling system was begun on May 31 and the water temperature has been stabilized at approximately 30^{o}C at present.

- *Current status of the RPV*

As of August 31, water injection was being undertaken at a flow rate of approximately 3.8m^3/h, which exceeds the flow rate equivalent to decay heat. The temperature at the bottom of the RPV is below 130^{o}C and trending in a stable manner without showing any continuous increasing trends for the past month, which indicates that sufficient cooling has been secured via the circulating water injection cooling system. The injection of nitrogen into the PCV has been underway since starting the injection on June 28.

4) Unit 3 of Fukushima Dai-ichi NPS

- *Initial cooling*

Regarding Unit 3, even after the loss of all AC power on March 11, the RCIC was functioning for some time and cooling of the rector was maintained. However, at 11:36, March 12, the RCIC was tripped. HPCI, whose operation was begun immediately following that, which means at 12:35 on the same day, stopped at 02:42, March 13. In light of this situation, TEPCO attempted to restart the injection of water using existing cooling facilities (HPCI, RCIC, diesel-powered fire pumps), but the HPCI failed to operate due to battery depletion. An injection of water into the RPV was also attempted upon confirming the site conditions, but the RCIC failed to begin operating.

- *Alternative water injection*

After the restoration of roads within the site located to the side of units 5/ 6, including the removal of debris and other efforts, the recovery of the fire engines which were parked to the side of units 5/6, and the transfer to Fukushima Dai-ichi NPS of a fire engine which had been positioned as a backup for emergencies at Fukushima Dai-ni NPS, in the early morning of March 13, a line for an injection of water was developed by which freshwater was taken from the fire cistern. In order to depressurize the RPV, it became necessary to operate the main steam safety relief valves (SRV), but due to a lack of working batteries, batteries were removed from cars employees used for commuting and collected. Rapid depressurization of the RPV was implemented using these batteries as a power supply. Following this, at 09:25 on the same day, alternative water injection with fire engines was launched. When freshwater from the fire cistern, the water source, was depleted, at 13:12 on the same day, a seawater injection was begun by developing the line which injects seawater of the backwash valve pit. The explosion of the reactor building on March 14 caused the backwash valve pit to become unusable. Having attempted other sea water injections, around 16:30, March 14, seawater injections were developed that directly took in seawater, and seawater injection via fire engines resumed.

- *PCV venting*

At around 4:50 on March 13 the operation to open the vent valve was started for the PCV vent, and the S/C large valve (AO valve) was not able to be opened despite the forcible energization of the electromagnetic valve for activating the large valve using a small generator, so it was made to open by changing cylinders. Also, the operation to open another vent valve was performed manually (open 15% of the stipulated procedure), the vent lineup was complete at around 8:41 on March 13, and TEPCO awaited the blowout of a rupture disk. At 9:24 on March 13 it was confirmed that drywell pressure had decreased from 0.637 MPa abs (at 9:10 on the 13^{th}) to 0.540 MPa abs (at 9:24 on the 13^{th}), so that TEPCO judged that venting had been conducted. However, after that, there was the repeated closure of a vent valve due to decreased air pressure, so that the operation to open the valve was performed each time by changing cylinders, etc.

- *Situation of the spent fuel pool*

Due to the loss of all AC power and the consequent loss of the seawater pump function due to the earthquake and tsunamis on March 11, the functions of cooling and of make-up water were lost. The entire upper side exterior-wall of the operating floor at the reactor building was damaged by an explosion assumed to have been a hydrogen gas explosion on March 14, and a large amount of rubble fell down onto the spent fuel pool. A large amount of steam emissions from the exposed operating floor was confirmed because of the damage to the building. On March 17, the spraying of seawater to the upper side of the reactor building by helicopter of the Self-Defence Force began. Spraying toward the spent fuel pool through the use of a water spraying truck also started on the same day. Water injection by a concrete pump truck began on March 27, and water injection from the piping of the existing fuel pool cooling and cleanup system was started on April 26. Through this effort, it is highly likely that exposed fuel has been avoided by maintaining the water level at the spent fuel pool. An alternative cooling system has been in place since June 30 and the water temperature is presently stabilized at approximately 30^{o}C.

- *Current status of the RPV*

As of August 31, water injection was being undertaken at a flow rate of approximately 7.0m^3/h, which exceeds the flow rate equivalent to decay heat. The temperature of the bottom of the RPV is below 120^{o}C and trending in a stable manner without showing any continuous increasing trend for the past month, which indicates that sufficient cooling has been secured by means of the circulating water injection cooling system. The injection of nitrogen into the PCV has been underway since starting the injection on July 14.

5) Unit 4 of Fukushima Dai-ichi NPS

- *Situation of the spent fuel pool*

Due to the loss of all AC power and the consequent loss of the seawater pump function due to the earthquake and tsunamis on March 11, the functions of cooling and of make-up water were lost. The upper wall side and other portions of the operating floor were damaged by an explosion assumed to have been a hydrogen gas explosion on March 15. The spraying of freshwater by Self-Defence Forces water spraying trucks began on March 20 and has been conducted periodically ever since. Injections using a temporary fuel pool injection facility were also launched on June 16. After analyzing the results, etc. of nuclide analysis of the pool water sample, most of the fuel inside of the pool appears to be in sound condition and it is presumed that systematic mass-damage has not occurred. In this respect, due to damage at the reactor building at Unit 4, the possibility that part of the fuel was damaged by rubble falling into pool cannot be ruled out. An alternative cooling system has been in place since July 31 and the water temperature is presently stabilized at approximately 40^{o}C.

In addition, the installation of a supportive structure at the bottom of spent fuel pool was completed on July 30 and seismic safety has been enhanced.

6) Fukushima Dai-ni NPS

In Fukushima Dai-ni NPS (BWR of Units 1~4), before the earthquake on March 11, all four units were in operation. One external power supply line was secured for the entire Fukushima Dai-ni NPS, and therefore the securing of an AC power supply was successfully achieved. Regarding Units 1 and 2, the turbine-driven injection system was ensured, and, in the case of the motor-driven injection system, despite the entirety of the emergency core cooling system (ECCS) becoming unusable, all other injection systems except the ECCS were ensured. Thus, core cooling was successfully achieved. Regarding Units 3 and 4, the turbine-driven injection system was ensured, and insofar as motor-driven injection system, part of ECCS and other injection systems were ensured, so that core cooling was successfully achieved. Regarding the removal of decay heat from the PCV, as for Unit 3, since the residual heat removal system (RHR) was ensured, continuous cooling was implemented which led to a cold shutdown. Regarding Units 1, 2 and 4, though the heat removal function was lost due to tsunamis, one RHR system was restored by replacing motors, installing temporary cables, receiving power from temporary cables, and receiving power from high voltage power supply vehicles, and in this way, a cold shutdown was achieved.

7) Other NPSs affected by the earth quake and tsunami

- *Onagawa NPS*

In Tohoku Electric Power Company Onagawa NPS (BWR of Units 1~3), Units 1 and 3 were operating, and Unit 2 was in the process of starting reactor operation. Even after the earthquake and tsunami, one external power supply line was secured for the entire NPS. Due to a fire at the normal distribution panel, Unit 1 could not supply power to the emergency distribution panel, thus it could not use an external power supply. However, by activating the emergency diesel generator, it could secure an AC power supply. As for core cooling, the turbine-driven water injection system and motor-driven water supply system were secured in Units 1 and 3, and core cooling was successful. Regarding Unit 2, the operation of pulling out the control rods for starting up the reactor was carried out, and the water temperature in the reactor was 100ºC or less and immediately resulted in cold shutdown. Regarding removal of decay heat from the PCV, all Residual Heat Removal Systems (RHR) could be secured in Units 1 and 3, and were kept cool and resulted in a cold shutdown. As for Unit 2, the water temperature was 100 ºC or less, and it shifted directly to cold shutdown. One RHR system became dysfunctional due to the following tsunami, but one other system was available, and this was successful in securing the removal of decay heat.

- *Tokai Dai-ni NPS*

The Japan Atomic Power Company Tokai Dai-ni NPS (BWR of 1 Unit) was in operation before the earthquake on March 11.Due to the earthquake, three external power supply lines were stopped and thus external power supply was lost. All emergency diesel generators started operating. After that, although one system became unusable due to the tsunamis, through the use of another emergency diesel generator and a high-pressure core spray system (HPCS), AC power supply from diesel generators was successfully achieved. Regarding core cooling, one motor-driven water supply system could be secured, and core cooling was successful. As for the removal of decay heat from the PCVs, since one system of power supply was secured by an emergency diesel generator, and one system of power supply was secured by Residual Heat Removal System (RHR) as well, it required some time, but cooling was maintained and it resulted in a cold shutdown.

(3) Response regarding Evacuation Areas, etc

The Japanese government has established Evacuation Areas, etc. as necessary in order to avoid the accident impacting the residents in the surrounding areas. As was described in the June Report, the Director-general of the Nuclear Emergency Response Headquarters instructed the mayors concerned of the cities, towns and villages to establish the area within 20 km radius of the Fukushima Dai-ichi NPS as a restricted area from April 22 and residents have in principle been prohibited from access to the area. At the same time, it permits both residents to temporarily access their own residences (residents' temporary access) and public organizations and enterprises, etc. , whose public interest are badly damaged without temporally access to the area, to temporarily access the area (public temporary access). The first round of residents' temporary access for all the cities, towns and villages in the area was almost complete by August 31, with 19,683 households (33,181) people having been granted temporary access by August 31.

On April 22, the government established as the Deliberate Evacuation Area the area in which the cumulative dose might reach 20 mSv within a year from the occurrence of the accident. The residents in this area have almost completed evacuation to date. Regarding the Evacuation-Prepared Area in Case of Emergency which was established on the day as the Deliberate Evacuation Area, in which a response of "stay in-house" and/or evacuation was required in case of emergency, efforts are currently being made to lift the designation (cf. 4.(2) below).

In addition, since June particular spots have been found, which have no areal spread but of which cumulative dose might reach 20 mSv within a year from the accident occurrence depending on a life style, the government has identified their residences as Specific Spots Recommended for Evacuation, and it was decided for the residents living at the spots first to draw attention to these spots and then support and promote evacuation. To date, 227 spots have been established as Specific Spots Recommended for Evacuation, covering 245 households.

(4) Situation regarding the release of radioactive materials

The Japan Atomic Energy Agency (JAEA) reported on May 12 to the Nuclear Safety Commission (NSC) about its trial calculation of the amount of release to the atmosphere of iodine-131 and cesium after the accident occurred, and, as the result of emergency monitoring from March 12 to 15 was thus newly confirmed, the JAEA reevaluated and reported the result to the NSC on August 22.

For the current release amount of radioactive materials at the site, TEPCO, using a graph of the concentration distribution which had been made in advance by means of observed data of concentration measurements of radioactive materials in the atmosphere near the site and a diffusion model (a diffusion model based on the “Regulatory Guide for Meteorological Observation for Safety Analysis of Nuclear Power Reactor Facilities” of the NSC), estimated the current release amount of radioactive materials to the atmosphere. As a result, at a time in early August, the release amount including the total of both cesium-137 and cesium-134 per unit time was estimated to be approximately 2.0×10^{8} Becquerel/hour (Bq/h).

The government, to assess the impact of radioactive materials released from the Fukushima Dai-ichi NPS, has actively continued environmental monitoring. In July, the government established the “Monitoring Coordination Meeting” to promote precise implementation and evaluation of monitoring based on the overall results of wide-range environmental monitoring performed by related ministries and agencies, municipalities and the operators. The Coordination Meeting determined the “Comprehensive Monitoring Plan” on August 2 to perform careful monitoring without omissions regarding 1) general environmental monitoring, 2) harbors, airports, etc., 3) the water environment, etc., 4) agricultural soil, forests and fields, etc., 5) food, 6) the water supply, in cooperation with related organizations.

For the outflow of radioactive materials to the sea from the Fukushima Dai-ichi NPS, TEPCO implemented measures to prevent outflow and mitigate diffusion, including the closure of the seawater piping trench located in the upper part of outflow routes as well as blocking pits having outflow risk. The concentration of radioactive materials in seawater near the NPS' water intake and water discharge locations has now decreased to a level near the regulatory concentration value defined by law. However, in the future, there is the possibility that accumulated water might leak under ground and increase contamination of the sea. In light of this situation, the installation of a water shielding wall (at the seaside) made of steel pipe sheet pile with an adequate water shielding function in front of the existing seawall of Units 1 to 4 is planned. Beyond this, the installation of a water shielding wall (at the land side) surrounding the reactor buildings of Units 1 to 4 is also being investigated and examined.

The Ministry of Education, Culture, Sports, Science and Technology (MEXT), on the basis of "Sea Area Monitoring in Wider Areas" published on May 6, has been continuously implementing monitoring of radioactivity concentrations in refuse on the sea surface, in the seawater and in the marine soil in the sea beds off the coast of Miyagi, Fukushima and Ibaraki Prefectures, etc. in cooperation with related organizations.

(5) Situation regarding radiation exposure

Regarding the total value of the external and internal exposure of the workers, while the average value of 3,715 people was as high as 22.4 mSv in March, there is a declining tendency, with 3.9 mSv as the average value of 3,463 people in April and 3.1 mSv as the average value of 2,721 people in May.

Particularly in March, it was confirmed that six people exceeded 250 mSv, which is the dose limit for an emergency worker. All of these were TEPCO employees who were operators and engineers in electricity and instrumentation engaged in monitoring of instruments in the main control rooms immediately after the occurrence of the accident. TEPCO has made it a rule not to allow workers who have exceeded 200 mSv to work at the Fukushima Dai-ichi NPS.

For residents, Fukushima Prefecture intends to implement the “Health Management Survey for the Residents in Fukushima Prefecture” directed at all its residents, who number about two million. In concrete terms, a basic survey based on behavioral records, etc., is scheduled and a detailed survey will be implemented for the residents living in Evacuation Areas, etc. Moreover, supersonic thyroid examinations will be implemented for all residents who are 18 years old or younger. As part of the previous survey of the basic survey, a survey of internal exposure by using a whole body counter, etc. was implemented for 122 residents in areas where the possibility of internal exposure might be relatively high. The internal exposure to the total of cesium-134 and cesium-137 by these subjects was assessed as less than 1 mSv.

(6) Situation regarding measures to address agricultural products, etc.

From viewpoints of securing health, security, and safety of the citizens as well as international community, the government is promoting enhanced efforts on inspection of agricultural products and distribution restriction as necessary, etc., based on provisional regulation values of radiation dose comparable to those of major countries. Regarding agricultural products, etc., on June 27, the Government Nuclear Emergency Response Headquarters (GNER HQ) re-summarized the policy for restricting distribution and intake and also for lifting such orders, on the basis that radioactive cesium exceeding the provisional regulation values has been detected in some food even as the level of radioactive iodine detected in food has been decreasing. Based on this, relevant municipalities are carrying out distribution restrictions and also lifting these restrictions in accordance with the monitoring results of radioactive materials.

As for the specific handling by the government regarding tea in tea fields where the concentration of radioactive cesium of dried tea leaves exceeds provisional regulation values (500 Bq/kg or less) or has a risk of it, Ministry of Agriculture, Forestry and Fisheries (MAFF) provides guidance towards planning to decrease the amount of radioactive cesium by carrying out “deep-skiffing,” which is to prune 10 to 20 cm from the top to the degree that no leaf layers remain. Also, radioactive cesium exceeding the provisional regulation values was detected in beef, and, since it is believed that cattle consumed rice straw collected after the accident and containing radioactive cesium, in conjunction with calling for attention to the handling of rice straw, distribution restrictions of cattle were established. Regarding rice, in cities, towns and villages where radioactive cesium concentration in soil is high, preliminary investigations were carried out in advance in order to figure out the tendency towards concentrations of radioactive materials at a stage before harvesting, and measurement at the post-harvest stage as the main investigation will be carried out, measuring radioactive materials to decide whether or not a restriction on distribution is necessary. On the basis of this concept of the government, the inspection of rice for radioactive materials has been conducted by relevant municipalities, and radioactive materials exceeding provisional regulation values have not been detected to date (August 31). Also, regarding fertilizer, soil amendments, nursery soil, and feed, provisional acceptable values regarding the concentration of radioactive cesium were defined and inspection methods, etc. were established.

3. Efforts to Settle the Accident

On July 19, the Nuclear Emergency Response Headquarters confirmed that the roadmap to settle the situation regarding the accident will transition from Step 1 to Step 2. This was the result of a comprehensive assessment of the situations including that the radiation doses indicated by monitoring posts, etc. were steadily on the decrease, efforts to cool the reactors and spent fuel pools have progressed, the treatment of stagnant water has progressed, etc.

Under Step 2, from October of 2011 to January of 2012, efforts will be made to achieve a situation in which the release of radioactive materials is under control, and the radiation exposure dose is being significantly held down through the realization of the cold shutdown of the rectors etc. The Nuclear Emergency Response Headquarters positioned Step 2 as an effort to be undertaken by the Government-TEPCO Integrated Response Office, and that the government will be sufficiently engaged to settle the accident, including efforts to improve the life and work environment for workers, the enhancement of radiation control and the medical system, and the training of staff. The government will make its utmost efforts to surely achieve the goals of Step 2 and settle the accident as soon as possible.

As the specific situation so far, regarding stable cooling of reactors, in Step 1, in consideration of the achievement of treating stagnant water and stable water injection using it (circulation water cooling), the securing of reliable water injection (actions to address an abnormal event, more than one measure for water injection, etc.), and the avoidance of the risk of a hydrogen explosion accompanying the nitrogen injection into the PCV, the targeted “stable cooling” in Step 1 was realized.

Currently, the actual amount of injected water exceeds the amount of water equivalent to the decay heat, and the temperature of RPV has been stable. Hereafter, regarding Units 2 and 3, where the temperature at the bottom of the PRV exceeds 100^{o}C, the amount of water injection will be modified on a trial base in order to change the temperature inside the reactor and the amount of water necessary to be injected to achieve a cold shutdown condition will be evaluated.

Regarding the cooling of the spent fuel pools, by August 10, “more stable cooling” (a target in Step 2) was achieved before others, as circulating cooling with heat exchangers has been implemented in all Units (1, 2, 3 and 4).

In order to implement the treatment of stagnant water and more stable and efficient injection of treated water into the reactor, as second-line treatment facilities**,** on August 7, treatment began with evaporative concentration equipment, which reinforces the desalination process. The current accumulated amount of the treated stagnant water is approximately 66,980 tons (as of August 31) and the cesium decontamination factor achieved by the treatment facilities is 10^6. (Note: The “decontamination factor**”** is the ratio of the concentration of cesium in the sample before treatment to the concentration of cesium in the sample after treatment.)

In order to improve the life and work environment for workers, TEPCO installed provisional dormitories as well as rest facilities in the NPS in sequence. Also, in order to improve health control for workers, a medical room has also been installed in the NPS, and the medical systems have been improving by deploying multiple doctors in a seismic isolation building to provide a 24-hour care system etc.

4. Responses to people suffering as a result of the nuclear accident (Off-site)

(1) Off-site measures

The Nuclear Emergency Response Headquarters established the “Roadmap for Immediate Actions for the Assistance of Residents Affected by the Nuclear Incidents” on May 17. Currently it is promoting efforts targeting the Evacuation Areas, the reinforcement and continued implementation of monitoring, and efforts such as decontamination and countermeasures against radioactive waste, etc. with full force in line with the Roadmap. The government will promptly promote such efforts in cooperation with related parties such as local municipalities.

(2) Efforts to lift the designation of Evacuation-Prepared Area in Case of Emergency

The NSC has indicated conditions, etc. for the lifting of each of the designations of Evacuation-Prepared Area in Case of Emergency, Evacuation Area, and Deliberate Evacuation Area, taking into account radiation protection and reactor stability under the "Basic Policy of the Nuclear Safety Commission of Japan on Radiation Protection for Termination of Evacuation and Reconstruction" (July 19) and "Standpoint of the Nuclear Safety Commission for the Termination of Urgent Protective Actions implemented for the Accident at Fukushima Dai-ichi Nuclear Power Plant" (August 4).

Based on the above initiatives, the Nuclear Emergency Response Headquarters indicated the "Concept of Review of Evacuation Area, etc." on August 9. The Japanese government intends to lift the designation of Evacuation-Prepared Area in Case of Emergency in block at the stage when all local municipalities have completed the development of a restoration plan based on their residents' intentions.

Therefore, related organizations are currently promoting environmental monitoring actively with a view to the lifting of the Evacuation-Prepared Area in Case of Emergency. Whole area environmental monitoring of the sites of schools and other public facilities, school zones and parks, etc. and environmental monitoring in response to individual requests of cities, towns and villages, etc. have been performed.

(3) Preparation of maps indicating radiation doses, etc.

The MEXT collected soil at about 2,200 places within a roughly 100 km radius from the TEPCO's Fukushima Dai-ichi NPS while also measuring the air dose rate and the amount of radioactive materials deposited into soil at these locations. It has made it a rule to prepare distribution maps of radiation dose, etc. on the basis of these measurements; so far, it published an air dose rate map on August 2 and a concentration map of radioactive cesium in soil on August 30.

(4) Enactment of the Act on measures for radioactive wastes and the basic policy of decontamination

The Diet enacted the “Act on Special Measures concerning Handling of Radioactive Pollution” on August 26. In light of the fact that contamination of the environment has been occurring on account of radioactive materials discharged by the recent accident, the Act intends to reduce impacts on human health and/or living environment promptly by establishing measures to be taken by the national and local governments and relevant licensees, etc. Specifically, it stipulates that the national government is to establish the basic principles regarding the handling of contamination of the environment by radioactive materials, and, giving due consideration to the degree of significance of the contamination, designate areas where it is necessary to take measures including decontamination by the national government and so on.

As decontamination is an urgent issue to be tackled immediately, the GNER HQ established the “Basic Policy for Emergency Decontamination Work” on August 26 without waiting until the related part of the above-mentioned Act fully comes into force in next January. It summarized specific targets and working principles in carrying out decontamination, including that estimated annual exposure dose of general public in residence areas is to be reduced approximately 50% in the next two years, and so on. In this policy, 1) with a central focus on areas where the estimated annual exposure dose exceeds 20 mSv, the national government directly promotes decontamination with the goal of reducing the estimated annual exposure dose to below 20 mSv, 2) effective decontamination is carried out through the cooperation of municipalities and residents also in areas where the estimated annual exposure dose is below 20 mSv, with a goal of bringing the estimated annual exposure dose to close to 1 mSv, and 3) particularly, by putting high priority on thorough decontamination work in children’s living areas (schools, parks, etc.), the goal is to reduce the estimated annual exposure dose of children close to 1 mSv as soon as possible, and then still lower, and so on. The contents of the basic policy are consistent with the above-mentioned Act and will be replaced when this Act fully comes into force. In order to promote these efforts by coordinating with the local areas the government launched “Fukushima Decontamination Promotion Team” and enhanced its on-site system on August 24. Also, on August 25, the Office of Response to Radioactive Materials Contamination was established within the Cabinet Secretariat and a system for comprehensively promoting decontamination, the disposal of radioactive wastes, and the health investigation of residents is to be prepared. In addition, a coordination meeting to facilitate close coordination among relevant ministries and agencies will be launched, as well as a radioactive materials contamination response advisory meeting, to be comprised of persons of knowledge and experience on the establishment of standards regarding radiation. Hereafter, the government intends to appropriate about 2 billion yen for these decontamination activities from reserve fund provided under a secondary supplementary budget for this fiscal year.

(5) Individual efforts concerning decontamination, etc.

- *Decontamination efforts made by municipalities*

In Date City, Fukushima Prefecture, prior to decontamination works of the whole city, a demonstration experiment targeting swimming pools and private residences was carried out, whereby the radiation dose was successfully lowered to a level that does not cause problems. Other local governments also have started decontamination and remediation activities.

- *Decontamination of residents' living spaces*

The GNER HQ, since radioactive materials were detected from soil and sand in the gutters as well as fallen leaves, carried out a demonstration experiment on the decontamination of gutters, etc., and compiled and presented instructions for cleaning these.

- *Decontamination efforts in schools, nursery schools, etc.*

In cases in which the air dose rate of the school yard, kindergarten yard, etc. exceeds 1 μSv/h, MEXT and the Ministry of Health, Labour and Welfare (MHLW), through financial support from the national government, will carry out measures to reduce the dose rate of school soils, etc., with the goal that the exposure dose for pupils and school children not be more than 1 mSv per year in principle after summer vacation.

- Dose reduction of public facilities and school zone, etc.

The national government funded for measures in Fukushima Prefecture for urgently preventing the effects of radiation on children, etc. in schools, parks, school zones, and public facilities, etc. currently used by children, residents, and others.

- Monitoring and decontamination of agricultural soils, etc.

With regard to agricultural land, the Ministry of Agriculture, Forestry and Fisheries (MAFF) collected samples of soil from about 360 points in Fukushima Prefecture and about 220 points in the surrounding 5 prefectures (Miyagi, Tochigi, Gunma, Ibaraki and Chiba Prefectures), promoted investigations into the status of contamination, and compiled a distribution map of radioactive materials concentrations (August 30).

MAFF, in cooperation with the Government Council for Science and Technology Policy, MEXT and the Ministry of Economy, Trade and Industry, has promoted the verification of the effectiveness of physical, chemical and biological decontaminating methods, has been working to develop technologies for decontaminating radioactive materials, and has been reviewing necessary measures for each decontamination status. Also, regarding all forested areas in Fukushima Prefecture, a distribution map of concentrations of radioactive materials is to be prepared similarly, and the future response will be examined accordingly.

- Disposal of disaster wastes, etc.

Ministry of the Environment compiled the "Policy on Disposal of Disaster Wastes in Fukushima Prefecture" on June 23. It stipulated the disposal method, etc. of incinerated ash that burnable waste is to be incinerated at incineration facilities fitted with bag-filter equipment and having exhaust fume absorption functions, and also that bottom ash contaminated with 8,000 Bq/kg or less is to be disposed by landfill. Subsequently, on August 31, the "Policy on Disposal Method of Incinerated Ash, etc. with Contamination that exceeds 8,000 Bq/kg and is less than 100,000 Bq/kg" was compiled.

5. Plans for the NPS site after restoration from the accident (On-site plans)

At the Fukushima Dai-ichi NPS where the recent nuclear accident occurred, there are plans to aim to remove the spent fuel and debris and, ultimately, to take measures for decommissioning. To achieve these objectives, the Mid- and Long-term Response Team of the Government-TEPCO Integrated Response Office is discussing for efforts to address these mid- and long-term challenges at “Advisory Committee on Mid- and Long-term Measures at the Fukushima Dai-ichi NPS of Tokyo Electric Power Co. Inc.,” (hereinafter referred to as “Advisory Committee on Mid- and Long-term Measures”) of the Atomic Energy Commission along with addressing issues by dividing them into mid-term challenges and long-term challenges.

Mid-term challenges include management of the groundwater on the site, integrity management of buildings and equipment, construction of reactor building containers, and the removal of spent fuel from the spent fuel pools. The Mid- and Long-term Response Team is currently discussing and designing the construction of groundwater boundaries on the ocean-side of the NPS site in order to prevent groundwater contamination from expanding, and is evaluating and discussing the safety of the reactor buildings in the event of a possible earthquake in the future in order to ensure safety. For the present, the removing spent fuels from the spent fuel pools, etc. will be tackled for the next three years, with preparations now underway, including the installation of equipment necessary to clear rubble scattered atop the reactor buildings and remove spent fuel, and modifications to the common pool to which spent fuels in the spent fuel pools are to be transferred.

Long-term challenges include the reconstruction of primary containment boundaries, extraction and storage of debris, management and disposal of radioactive waste, and decommissioning.

“Advisory Committee on Mid- and Long-term Measures of” the Atomic Energy Commission is currently discussing and putting together basic policies for efforts to address these mid- and long-term challenges and a set of research and development issues that are expected to be useful and helpful in pursuing those efforts. This Advisory Committee is identifying and sorting out technical challenges to be solved so that debris can be removed from the reactor pressure vessels (RPV) and then put under control, using examples from the activities at Unit 2 of the Three Mile Island nuclear power plant (hereinafter referred to as “TMI-2”) in the United States.

The Fukushima Dai-ichi NPS is in a difficult situation, including the facts that the placement of debris is not known, that debris may have accumulated at the bottom of the primary containment vessels (PCVs) due to damage to the RPV bottoms, unlike in the case of the TMI-2 accident, and the fact that it has been determined that the water injected to cool the RPVs has been flowing out of there into the PCVs, leaking from the PCVs into the bottom part of the reactor buildings, and then further into the turbine buildings from there. With this recognition, it has been decided that attention should be focused on identifying points of leakage of the cooling water and on figuring out the position and nature of the fuel while enabling the circulation pathway for cooling the RPVs to be shortened and debris to be handled, for which an accommodating environment should be put in place. To achieve this, work is now underway to identify technical challenges to be solved and corresponding research and development areas.

For example, the development of engineering and construction methods to locate the leakage points of the PCVs and then repairing them to stop water, thereby enabling the PCVs to be filled with water after the construction of boundaries, has been identified as one of these technical challenges. To achieve this, the development of robots for remote inspection around the PCVs and for repairs, as well as the development of engineering and construction methods for repairing assumed leakage points to prevent water from escaping, etc. have been identified as among the research and development areas.

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

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

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

Lessons in Category 1

Prevention of severe accidents

(1) Strengthen measures against earthquakes and tsunamis

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

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

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

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

(2) Ensure power supplies

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

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

(3) Ensure reliable cooling function of reactors and PCVs

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

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

(4) Ensure reliable cooling functions of spent fuel pools

In the accident, the loss of power supplies led to failure of the cooling for the spent fuel pool. The operators, under instructions from NISA, in order to maintain cooling of the spent fuel pool even when power supplies had been lost, deployed

alternative/external cooling water injection devices for the spent fuel pools (pump tucks, fire engines, hoses, coupling parts, etc.), ensured the capacity of freshwater tanks, and arranged feedwater lines that take water from the sea.
Beyond this, they plan to undertake seismic reinforcement of the cooling piping system for the spent fuel pool, etc. as future efforts.

(5) Thorough accident management (AM) measures

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

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

(6) Responses to multi-unit site issues

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

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

(7) Consideration of NPS arrangement in basic design

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

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

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

Lesssons in Category 2

Countermeasures against severe accidents

(9) Enhancement of measures to prevent hydrogen explosions

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

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

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

(10) Enhancement of the containment venting systems

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

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

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

(11) Improvements to the accident response environment

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

Under instructions from NISA, the plant operators have taken steps to ensure on-site communication tools (a power supply for on-site PHS communication facilities, transceivers) a portable lighting system, and means of securing a work environment in the main control room (a power supply by power-supply vehicles to the ventilation and air conditioning systems), etc.

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

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

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

(13) Enhancement of training for responding to severe accidents

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

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

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

(14) Enhancement of instrumentation for reactors and PCVs

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

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

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

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

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

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

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

Lessons in Category 3

Responses to nuclear emergencies

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

This time a massive natural disaster was followed by a nuclear accident to produce a complex disaster. Also, the prolonged nuclear accident caused difficulties in securing means of communication and of procurement as well as in the mobilization of the full range of support personnel for the accident and disaster response.

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

(17) Reinforcement of environmental monitoring

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

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

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

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

Therefore in responding to the current accident, local bases to respond to the accident were established by utilizing J Village and the Onahama Coal Center. Central organizations to coordinate response activities were also established, including the Government-TEPCO Integrated Response Office, the sufferers’ livelihood support team and the Office of Response to Radioactive Materials Contamination.

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

(19) Enhancement of communication regarding the accident

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

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

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

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

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

In light of this, in order to immediately notify neighboring countries in the case of an accident, contact points for each neighboring country have been specified. The list of contact points will be updated, as appropriate, to ensure the quick and accurate provision of information to the international community.

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

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

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

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

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

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

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

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

Japan will make efforts to reflect the Fukushima experience of accident responses within the review of the standards of International Commission on Radiological Protection (ICRP) and the IAEA standards for nuclear emergency preparedness and radiological protection.

Lessons in Category 4

Enhancement of safety infrastructure

(23) Enhancement of safety regulatory and administrative systems

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

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

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

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

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

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

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

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

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

(26) Ensuring the independence and diversity of safety systems

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

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

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

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

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

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

Lessons in Category 5

Thoroughly instill a safety culture

(28) Thoroughly instill a safety culture

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

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

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

7. Situation on deliberation to enhance standards etc

The NSC has been presenting various advice and basic policies based on the views indicated by the IAEA and the ICRP. Specifically, "Near-term policy to ensure the safety for treating and disposing contaminated waste around the site of Fukushima Dai-ichi Nuclear Power Station of Tokyo Electric Power Company", "Basic Policy of the Nuclear Safety Commission of Japan on Radiation Protection for Termination of Evacuation and Reconstruction", "Basic Policy on Radiation Monitoring from Now on", and "Standpoint of the Nuclear Safety Commission for the Termination of Urgent Protective Actions implemented for the Accident at Fukushima Dai-ichi Nuclear Power Plant" , etc. have been presented as basic policies and directions related to radiation protection measures to restore from the accident and to facilitate subsequent reconstruction.

In light of the recent accident at the Fukushima Dai-ichi NPS, the NSC has also started reviewing the NSC Regulatory Guides, such as the "Regulatory Guide for Reviewing Safety Design of Light Water Nuclear Power Reactor Facilities" and

“Regulatory Guide for Emergency Preparedness of Nuclear Facilities”, and has furthermore resumed to enhance severe accident countermeasures.

The Nuclear and Industrial Safety Agency (NISA) has started deliberating a review of safety standards and other matters. Also, NISA and the Japan Nuclear Energy Safety Organization (JNES) have started analyzing the 28 lessons learned through the June report, have proposed a review of the Guide for Seismic Design of Nuclear Facilities (NS-G-1.6) and Siting Guidelines (DS433) by the IAEA, etc., and also have worked to organize a Safety Report and Technical Document having concrete cases to which those guidelines were applied, etc. with the cooperation of the International Seismic Safety Center of the IAEA.

8. Further Safety Assessment Efforts for NPSs

On July 11, 2011, aiming to further improve safety at NPSs and ensure security and confidence of the public and local residents in terms of nuclear safety, the Japanese government decided to implement safety assessments based on new procedures and rules, basically by making use of international knowledge and experiences of stress tests, particularly those implemented in European countries.

More specifically, those NPSs that have undergone regular inspection and are prepared to start up will sequentially undergo safety assessments in terms of the degree to which safety margins are secured against beyond-design-basis events for facilities and equipment important to safety (preliminary assessments). In addition, all existing nuclear power stations including those in operation and those examined through this preliminary assessment will also undergo comprehensive assessments (secondary assessments), in consideration of the implementation of stress tests in Europe and the progress of the discussions by the Investigation Committee on the Accident at the Fukushima Nuclear Power Stations.

9. Conclusion

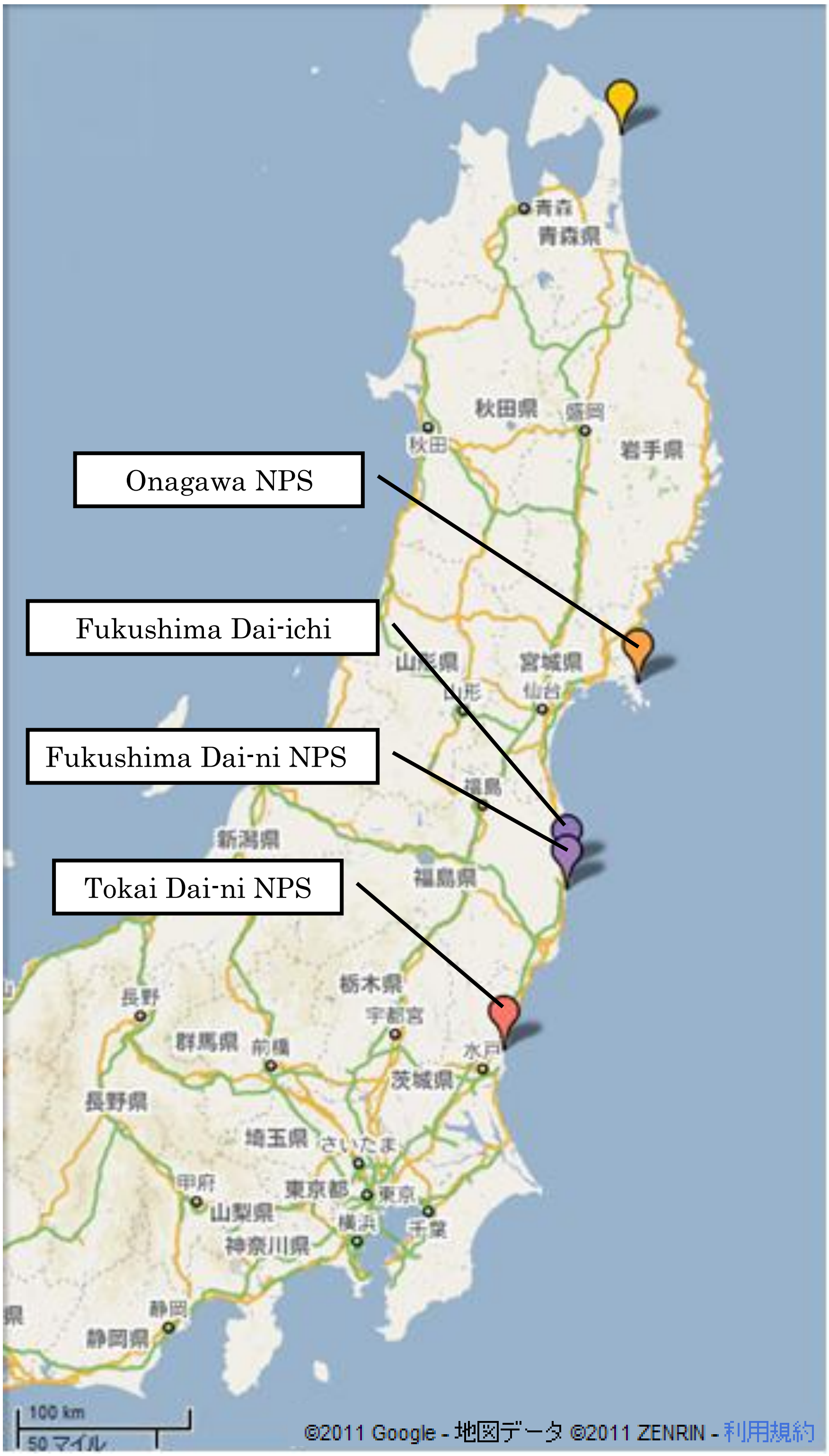
Approximately half a year has passed since the accident occurred at the Tokyo Electric Power Co. (TEPCO) Fukushima Nuclear Power Station. This nuclear accident caused by an earthquake and tsunamis is a massive accident unprecedented in Japan or abroad insofar as severe accidents occurred simultaneously at multiple units, that the accident has affected an extensive range in its surrounding area, and that it has been taking a long time to achieve restoration from the accident.

In Japan, related organizations such as TEPCO, the central government and local authorities, including the workers on the site, have been tackling this accident together. While progress has steadily been made with regard to restoration from the accident, such as stable cooling of the reactors and the spent fuel pools, it is far from easy to complete the restoration from the accident, dispose of the radioactive materials and the spent fuel thereafter and proceed with decommissioning of the nuclear reactors. Also, it is necessary to advance the efforts while listening carefully to the voices of the local people when responding to those who suffered as a result of the nuclear accident, including such responses as environmental monitoring and decontamination.

In this second report, the responses taken immediately after the occurrence of the accident at the Fukushima NPS and elsewhere have also been described in greater details. Moreover, it has described a situation in which the station employees and workers at the site, as well as personnel in related organizations, have been working hard in a severe environment that includes damage by an earthquake and by tsunamis, the impact of rubble, and the impact of debris scattered as a result of the hydrogen explosions. The Government of Japan is determined to continue its utmost efforts to support the health management and other aspects of the people engaged in this work.

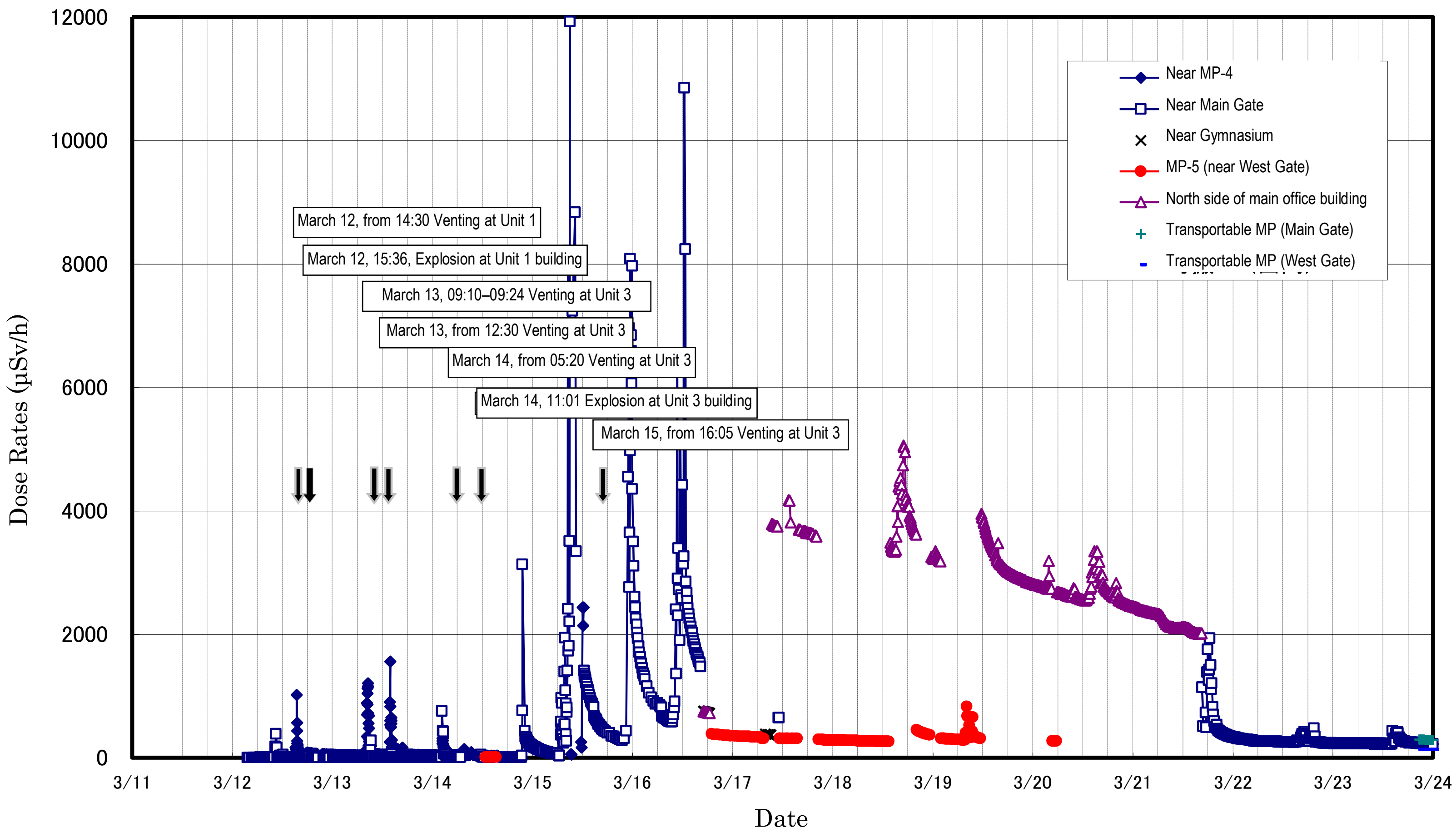
Japan has received a wide array of support from countries around the world, related international organizations, and others to date. Japan would like to express its deepest gratitude once more while also requesting continued support.

Japan is confident that it will overcome this accident without fail by mobilizing wisdom and efforts from around the world.



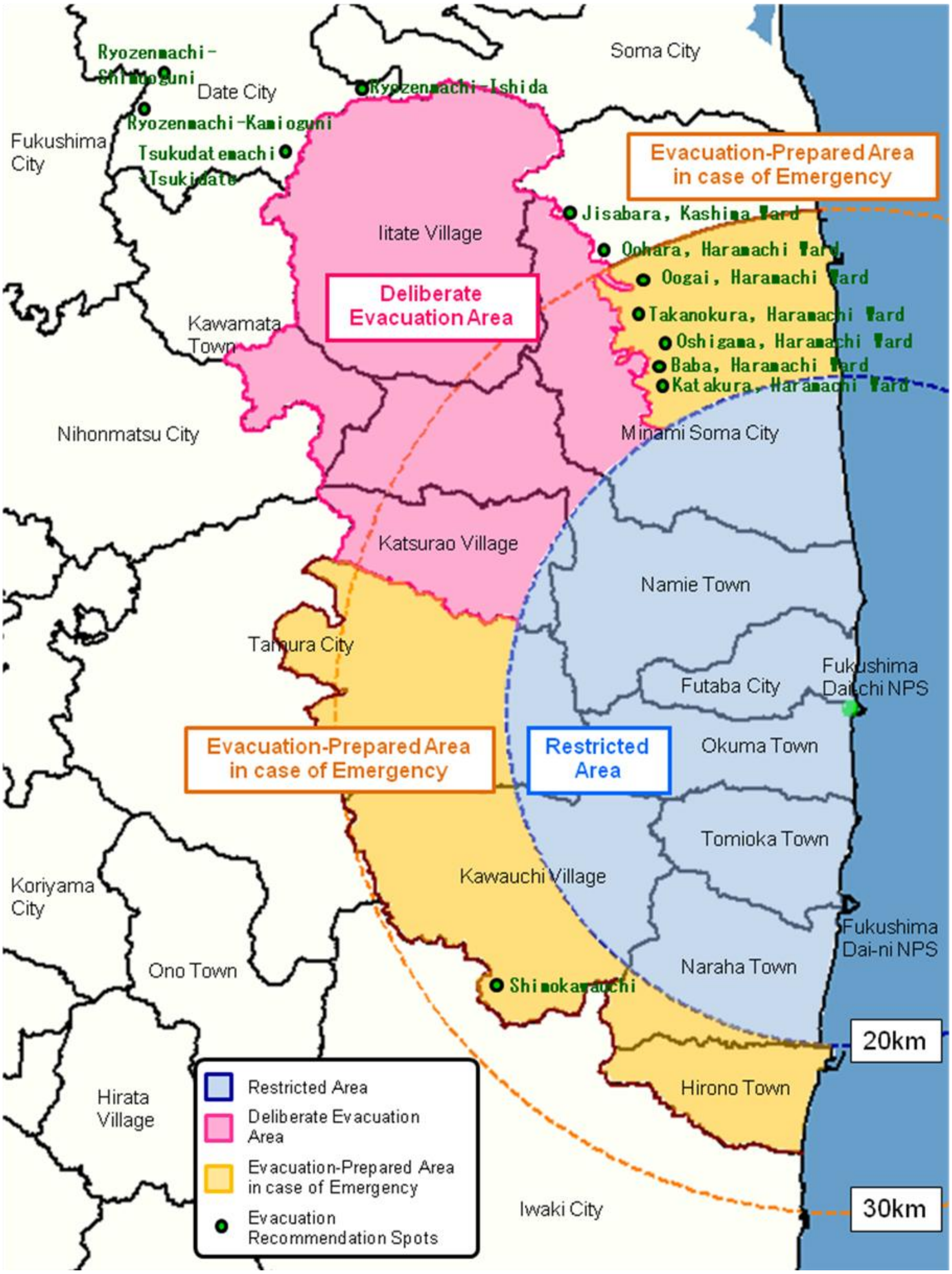
Location of NPSs affected by the Tohoku District - off the Pacific Ocean Earthquake

Changes in Dose Rates at Fukushima Dai-ichi (Monitoring Car)



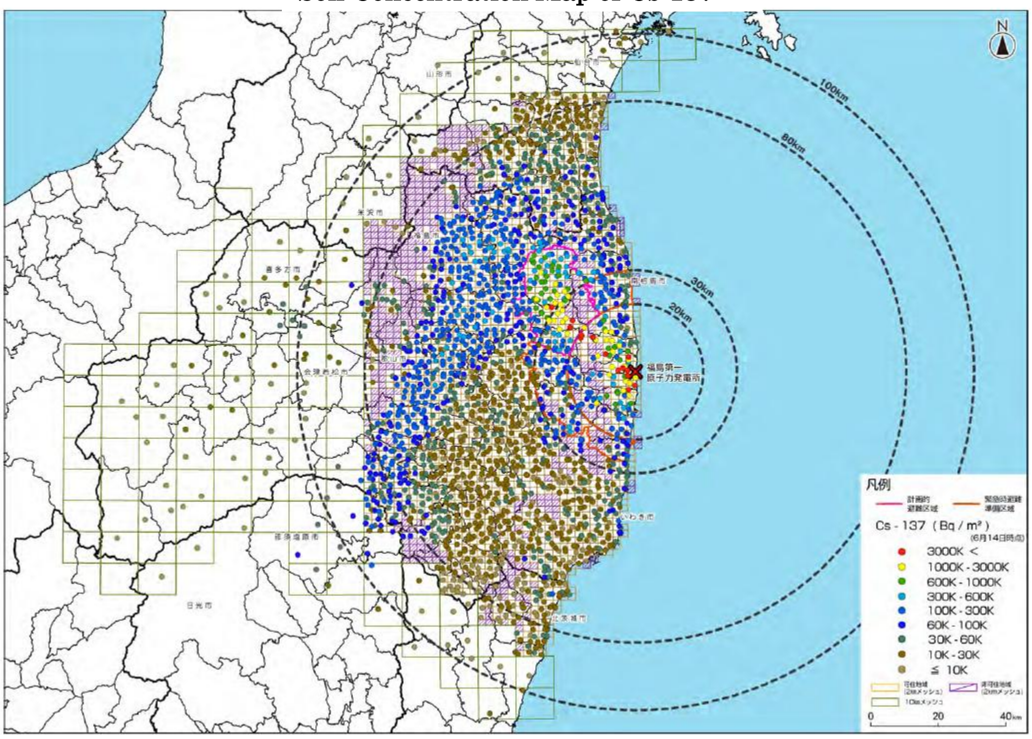
Measurement Results of Dose Rates by Monitoring Car at Fukushima Dai-ichi NPS

Resricted Area, Deliberate Evacuation Area, Evacuation-Prepared Area in case of Emergency And Evacuation Recommendation Spots (As of August 3, 2011)



Air Dose Rate Map
(As of August 11, 2011)

Soil Concentration Map of Cs-137



Status of Units 1, 2 and 3 of Fukushima Dai-ichi NPS
(As of August 27)

Unit	Unit 1	Unit 2	Unit 3
Status of water injection to the reactor	Fresh water feeding by feed water system Flow rate: 3.7m³/h	Fresh water feeding by feed water system Flow rate: 3.6m³/h	Fresh water feeding by feed water system Flow rate: 7.0m³/h
Reactor Water Level	Fuel range A: Downscale Fuel range B: -1,700mm	Fuel range A: -1,850mm* Fuel range B: -2,200mm*	Fuel range A: -1,550mm* Fuel range B: -2,000mm*
Reactor Pressure	0.017 MPa g(A) - MPa g(B)	0.013 MPa g(A) - MPa g(B)	0.080 MPa g(A) 0.001 MPa g(B)
Temperature around the reactor vessel	Temperature in feed-water nozzle: 92.2 ºC Temperature at reactor vessel bottom: 87.7 ºC	Temperature in feed-water nozzle: 106.9 ºC Temperature at reactor vessel bottom: 115.0 ºC	Temperature in feed-water nozzle: 113.9 ºC Temperature at reactor vessel bottom: 108.8 ºC
Pressure in D/W, S/C	D/W: 0.1275 MPa abs S/C: 0.105 MPa abs	D/W: 0.114 MPa abs S/C: Downscale	D/W: 0.1015 MPa abs S/C: 0.1817 MPa abs
Status	Each plant receives electricity from external power supplies. The process is carried on ensuring reliability of cooling function by installing temporary emergency diesel generators and the seawater pump etc.		

*These data may be modified when TEPCO makes evaluates them.