Station Accident Investigation Committee were still conducting investigation and verification activities, and therefore, it was necessary to base new policies on those issues on the results of the investigation and verification activities still underway. In this section, therefore, we will take a general view of such measures taken so far, as they are closely connected to S&T, to extract out of them issues that have already emerged. Further, in addition to the issues referred to in Section 1, 2 (1), we will newly organize in the next section the issues as S&T policy issues raised by the GEJE.

a) Establishment and Lifting of Evacuation Zones

With regard to evacuation of residents, since the first evacuation order was issued according to the "Act on Special Measures Concerning Nuclear Emergency Preparedness" (Act No. 156 enacted on December 17, 1999) on the night of March 11, 2011, the range of the evacuation area had been expanded as the situation grew more serious, but in late April, restricted area (within an area of 20km radius from TEPCO Fukushima Daiichi NPS), deliberate evacuation areas (areas which are within the surrounding area beyond a 20km radius from the Station where the annual integrated dose after the accident is more than 20mSv), areas prepared for emergency evacuation (areas which may require sheltering indoors or evacuation in exclusion of the stay indoors zones and deliberate evacuation areas), and specific spots recommended for evacuation (special spots where decontamination is not easy and the annual integrated dose after the accident is estimated to be more than 20mSv) were set up and operated. In size all these are far beyond the Emergency Planning Zones set up by prefectural governments based on the guidelines of the zones (Emergency Planning Zones: EPZs) for protective measures against nuclear disaster to be particularly facilitated (8 to 10km radius from the nuclear power plants), which had been determined by the Nuclear Safety Commission in "On nuclear disaster prevention measures in nuclear facilities (determined in June 1980 and revised in August, 2010)."

On May 17, the NERH publicized the "Immediate Actions for the Assistance of Nuclear Sufferers," and the "Roadmap for Immediate Actions for the Assistance of Nuclear Sufferers" to show their initiatives towards the convergence of the situation of the accidents at the said power plants, and then, prepared a "the basic concept for rearranging the areas of evacuation" on August 9, based on which evacuation zones were, etc. have been reviewed.

As a result, the areas prepared for emergency evacuation, in consideration of the completion of Step 1 and with advice from the Nuclear Safety Commission, were lifted on September 30. In addition, with the completion of Step 2, NERH December 26 determined "Basic Concept and Issues to be Challenged for Rearranging the Restricted Areas and Areas to which Evacuation Orders Have been Issued where Step 2 has been Completed." According to this, it is determined that although it is in principle appropriate to proceed with the lifting process on the restricted areas, it is necessary to make preparations before such lifting the restricted areas, and the areas to which evacuation orders have been issued (the areas to which evacuation orders have been issued within a 20km radius from the TEPCO Fukushima Daiichi NPS and) are to be set up as new areas to which evacuation orders have been issued (Areas to which evacuation orders are ready to be lifted , Areas in which the residents are not permitted to live , and Areas where it is expected that residents will face difficulties in returning for a long time). It also refers to common issues to rearrange the areas: ensuring safety and reassurance of the residents, drastic decontamination and providing care to children. Regarding ensuring safety and reassurance of the residents, the document

states that in order to sweep away the anxiety about contamination of the environment by radioactive substances from the accidents, the government will provide a community system where government officials and experts in various fields talk with residents continuously, foster community-based experts, establish information transparency, and prepare radiation measuring instruments in the areas involving residents as participants, as well as strong support for managing residents' healthcare, with the help of prefectural and municipal governments. By doing so, the government will propagate correct information on the effects of radioactive materials to people and conduct measures thereof.

Based on this, on March 30, 2012, NERH determined to review the restricted areas and the areas to which evacuation orders have been issued in Kawauchi Village and Tamura City on April 1, and those in Minamisoma City on April 16, and set them up as new areas and officially can be found in a public notice.

b) Planning and Implementation of Radiation Monitoring

In order to take appropriate measures for radioactive substances from the accident, it is necessary to accurately and timely grasp information about the effects of radioactive substances on the surrounding environment. For this reason, since the outbreak of the accidents at the TEPCO Fukushima NPS, relevant ministries, local governments, and businesses have cooperatively and more systematically carried out environmental radiation monitoring across the country, as well as the surrounding areas of the TEPCO Fukushima NPS. To be more concrete, the monitoring has been performed to grasp the radiation doses by monitoring cars and monitoring posts and conduct monitoring of radiation dose of soil, food, tap water and sea area in the vicinity of the TEPCO Fukushima NPS. All over the country, monitoring by aircrafts (airborne monitoring) has been performed, and monitoring posts have been installed in 47 prefectures to grasp the effects of the accidents on the environment.

However, various problems occurred with regard to emergency monitoring. For example, in the disaster prevention plan based on the Act on Special Measures Concerning Nuclear Emergency Preparedness before the occurrence of accidents, it was determined that in the event of an emergency, monitoring shall be conducted by local public institutions and nuclear operators under the leadership of the Government's local nuclear emergency response headquarters, but because of great damages caused by the earthquake and tsunami, measuring devices at the off-site center, where a local nuclear emergency response headquarters was to be established, were found to be not properly functioning, and monitoring devices and specimen analyzers owned by local governments or nuclear operators became unusable. Further, even after the arrival of supporting forces from the Government, the monitoring system did not work as originally planned, due to the effects of the damages caused by the earthquake and tsunami, and therefore it took a lot of time to have the system function properly. In addition, with regard to airborne monitoring, there was only a single measuring device managed by MEXT, and therefore, in order to conduct swift and detailed monitoring, Japan was forced to ask for assistance from the United States to implement airborne monitoring.

Under such circumstances, from the viewpoint of the Government decisively implementing monitoring, the policy on separate roles with respect to monitoring was arranged in the official residence on March 16, 2011: compilation and publication of monitoring data by MEXT; evaluation of the monitoring data by the Nuclear Safety Commission; and taking measures based on this evaluation by NERH.

MEXT moved the operating staff engaged in the System for Prediction of Environmental Emergency

Dose Information (SPEEDI) to the Secretariat of the Nuclear Safety Commission according to the above policy.

With regards to SPEEDI, it has been determined that the Nuclear Safety Technology Center conducts maintenance and management of the Central Information Processing Machine as a part of its investigation for advanced SPEEDI, commissioned by MEXT, and in the event of an emergency, the Center is to conduct, being subject to the instructions of MEXT, a prediction of external dispersion of radioactive substances, and transmit the results to relevant authorities. Therefore, after the occurrence of the Tohoku-Pacific Ocean Earthquake, the Center, receiving instructions from MEXT, was working on estimations of atmospheric concentrations of radioactive substances and air absorbed rate in the surrounding environment, assuming that 1 Bq of radioactive substance had been dispersed from the TEPCO Fukushima Daiichi NPS, and transmitted the results to the relevant authorities including the Nuclear Safety Commission.

The Nuclear Safety Commission conducted a trial calculation of the integrated dose in the surrounding environment based on the emissions of radioactive substances from the TEPCO Fukushima Daiichi NPS from March 16 onward estimated from the measurement results of atmospheric concentrations of radioactive substances in the surrounding environment; the results were publicized on March 23. MEXT conducted trial calculations of atmospheric concentrations of radioactive substance and absorbed air dose rate in the surrounding environment since March 11, assuming that 1 Bq of radioactive substance had been released from the TEPCO Fukushima Daiichi NPS, and has been publicizing the results since April 26, 2011. The Nuclear and Industrial Safety Agency (NISA) has also conducted trial calculations of atmospheric concentrations of radioactive substances and absorbed air dose rates from March 11 of the same year, assuming that various amounts of radioactive substances had been released from the TEPCO Fukushima Daiichi NPS, and has publicized the results since May 3 of the same year.

In the nuclear accidents, although the SPEEDI could not fulfill the function of predicting quantitative changes of the concentration of radioactive substances in the atmosphere, because of its inability to obtain the emission source information, MEXT and the NISA have used SPEEDI in such a variety of complementary ways as using it as a reference in setting up monitoring survey zones. However, various items have been pointed out about provision of information to the general public in the interim report by the Government's Accident Investigation Committee. At present, the Accident Investigation Committee and the Diet's TEPCO Nuclear Power Station Accident Investigation Committee are carrying out investigation and verification of these and other items.

Initially, each of relevant organizations had been engaged in such as air dose monitoring, food monitoring, but a "monitoring coordination meeting" composed of relevant ministries, Fukushima prefecture and nuclear operators is to be held in July, in order to promote coordination between relevant agencies and to definitely and designedly carry out radiation monitoring, and a "comprehensive monitoring plan" showing sharing of roles among relevant organizations and contents of monitoring to be conducted is to be determined in August. Based on the differentiated roles indicated in the said plan, relevant organizations have cooperatively conducted monitoring, and an online portal has been launched, so that it can jointly provide monitoring information obtained from relevant organizations. In addition, the "Radiation dose contour distribution map expansion website"[1] has also been launched, which shows on the map measurement results, including airborne monitoring, possible to enlarge.

In consideration of a review of the areas to which evacuation orders have been issued based on the basic concept shown by NERH in December 2011 and the growing concern about radioactive substances that are expected to flow into the sea from the rivers over the medium to long term, the "Comprehensive Monitoring Plan" was revised in March 2012, which shows that monitoring be newly implemented or strengthened, so that it can deal with the above-mentioned issues and that cooperation between relevant organizations be strengthened.

On the other hand, there are also various initiatives in survey research being developed. For example, through the use of the Strategic Funds for the Promotion of Science and Technology, in cooperation with more than 100 universities, research institutes, and local governments led by the Japan Atomic Energy Agency, MEXT, in order to confirm the effects of radioactive substances from the accident, created detailed "spatial dose rate map" and "soil concentrations map" of the area within a 100km radius from the TEPCO Fukushima Daiichi NPS. The Ministry also conducted a research on the status of transition of radioactive substances from the accident, and further, the Ministry of Agriculture, Forestry and Fisheries (MAFF) investigated the distribution of the concentration of radioactive substances in agricultural soils and forests in cooperation and collaboration with MEXT and local governments.

There are also cases where things contaminated by radioactive substances from the accident were distributed to other regions, which expanded the effects. For example, there are cases where radioactive substances have been detected in beef cattle of another area that had fed on the contaminated rice straw, and where relatively high radiation was detected in the concrete of newly built condominiums, which had been transported from some quarries located in the deliberate evacuation area. With regard to lakes and rivers, radioactive substances have not been detected so far in river water, but in the subsoil, and there are cases where the value of radioactive substance in some freshwater fish living in the subsoil exceeded the provisional regulation values. Since deposition of radioactive substances from the accident were confirmed in various parts of the Kanto region, meaning that the effects of the accident spread far and wide, it will be necessary to implement appropriate monitoring and decontamination in consideration of the migration of radioactive substances through natural phenomena and socio-economic activities.

On the other hand, there has been increased interest and demand for radiation measurement by residents in response to this accident. There were cases[1], where a source of radioactive radium was discovered under the floor of a house in Setagaya-ku, and where there were spots relatively higher in radiation than the surrounding area, which were discovered and reported by local residents. With regard to radiation measuring instruments required for this kind of measurements, there may occur cases, where the measurement results will be inaccurate due to their performance and use, and therefore, it is necessary to provide proper information about such matters as instruments and methods of use. National Consumer Affairs Centers of Japan tested the performance of relatively inexpensive radiation measuring instruments to find that there are many cases where air dose rates cannot be accurately measured, and introduced the results[2] on the website.

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1 All the cases are not necessarily related to the radioactive substances from the accident. For example, the radiation source of radioactive radium was found in a private house in Setagaya-ku was contained in the bottle in the box that was discovered under the floor of the house.

2 Refer to "Performance of relatively inexpensive radiation measuring instruments" (Independent Administrative Institution National Consumer Affairs Center of Japan, September 8, 2011).

Figure 1-1-9 / Diffusion of Radioactive Substances from the Accident

The total deposition of Cs-134 and Cs-137 on the ground surface throughout all of East Japan, reflecting the results of the fourth airborne monitoring

Source: MEXT, "Results of the Fourth Airborne Monitoring Survey" (December 16, 2011)

c) Effect of Radiation on Human Health

As for local residents' health control, tests such as emergency radiation exposure screening have been conducted, under the direction of the Fukushima prefectural government, immediately after the accident by experts at the Japan Atomic Energy Agency (JAEA), National Institute of Radiological Sciences (NIRS), universities or other agencies. "The Fukushima Health Management Survey" has also been set off from a long-term perspective. The purpose of the survey is to conduct thyroid testing on every resident aged 18 or younger, who was within Fukushima Prefecture at the time of the accident, and to understand exposure dose of entire Fukushima population. The survey results will equally be important for those who were investigated because it informs them on their own estimated value of exposure dose. Using these survey results as the most useful information for further analysis and future reference, accurate information needs to be continuously collected.

Moreover, "Working Group on Risk Management of Low-dose Radiation Exposure" under the Office of Deputy Chief Cabinet Secretary, analyzed both domestic and international scientific findings related

to low-dose exposure, including previous epidemiologic research results on the atomic bomb survivors of Hiroshima and Nagasaki, and residents living in the vicinity of Chernobyl nuclear accident site. Based on these findings, the working group discussed a number of particular issues, such as how much risk of annual exposure dose of 20 millisieverts (mSv) is, set as a standard level for issuing evacuation order, what issues that require particular attention, such as handling of children and pregnant women, and appropriate way of risk communication. Proceedings of the discussions by the Working Group were published, a wide range of domestic and international opinions were taken into consideration, and "Report: Working Group on Risk Management of Low-dose Radiation Exposure" was compiled on December 22, 2011. Below are a few excerpts from the report;

- According to scientific findings based on international consensus, increased risk of cancer from low-dose radiation exposures at 100 mSv or less is so small as to be concealed by carcinogenic effects from other factors, making verification of any clear cancer risk from radiation exceedingly challenging. Nevertheless, from the perspective of radiation protection, special measures should be adopted to reduce risk from exposure by making determinations on the side of safety, based on the concept that risk increases in linear fashion with radiation dose, even in such cases of low-dose exposures of 100 mSv or less. The level of an annual dose of 20 mSv is believed to be an appropriate starting point toward further reduction of dose exposures in the future.
- Even in low-dose exposures of no more than 100 mSv, adoption of measures for radiation protection with a priority placed on children is appropriate, given the significant unease experienced by residents of the affected area. However, because children are thought to be highly sensitive to the effects of stress and so on associated with attempts to avoid radiation exposure, deliberate measures for caring children are considered to be of paramount importance.
- Having residents actively participate in both long-term and effective radiation protection efforts is crucial. For that reason, government and specialists must take on risk communication from the viewpoint of residents that provides intelligible and transparent information based on widely accepted scientific facts.

d) Promotion of Soil and Other Resources Decontamination

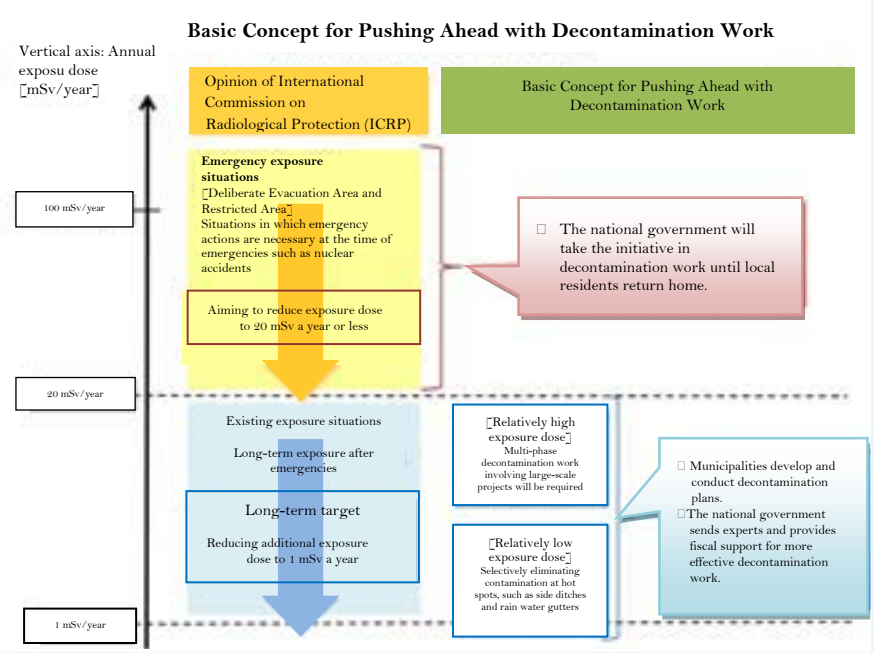
On August 26, 2011, NERH decided on "Basic Concept for Pushing Ahead with Decontamination Works" and "Basic Policy for Emergency Response on Decontamination Work," in which they summarized the immediate goals and work policies to pursue in the next 2 years (Figure 1-1-10).

In addition, "Act on Special Measures concerning the Handling of Environment Pollution by Radioactive Materials emitted by NPS related to the 2011 Off the Pacific coast of Tohoku Earthquake that occurred on March 11, 2011 (Act No.110 of August 30, 2011) (hereinafter referred to as "Decontamination Special Measures Act")," also enacted on the same day, and came into effect on January 1, 2012. The Ministry of the Environment (MOE) then released a roadmap toward full-scale decontamination on January 26, 2012. Since this is the first attempt for Japan to implement such a large-scale decontamination operation, demonstrations of decontamination model projects and advance decontamination in high-dose radiation area will concurrently be conducted, and all the acquired knowledge will be utilized for the purposes such as establishment of future decontamination technology.

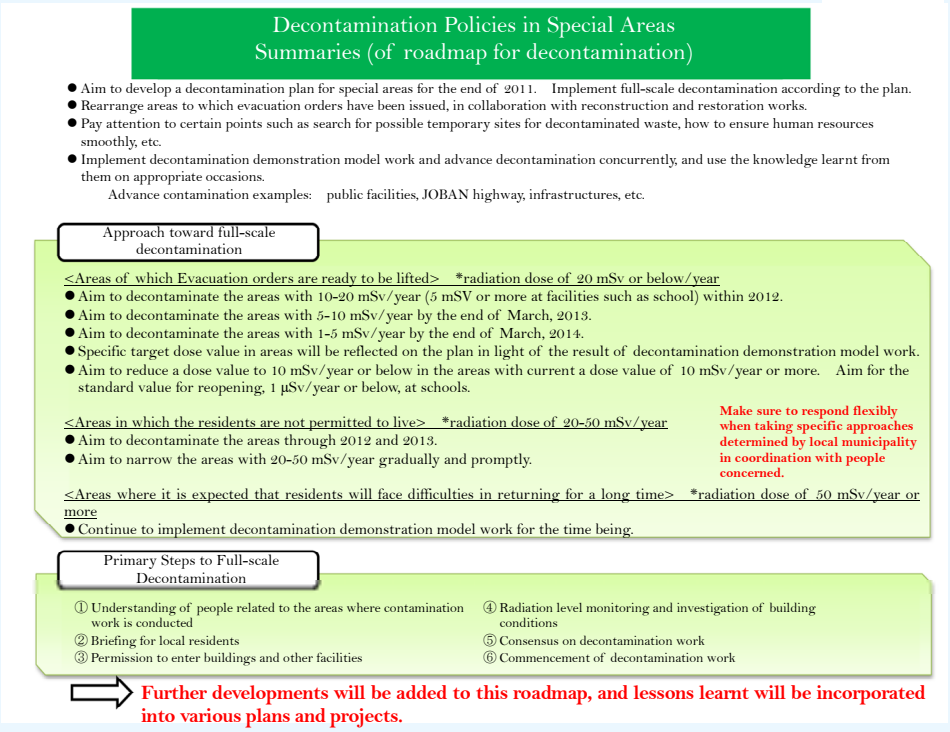
Given the facts that the contamination of soil and other resources by radioactive substances from the accidents covers a widespread area, and that local residents and volunteers are involved in decontamination work, it is necessary for them to be fully aware of the working methods, as well as points of concern, and receive advice and instructions from experts.

MOE has formulated "Decontamination Guidelines" to provide specific and simple explanations about the process toward decontamination based on the Special Measures Act. The Ministry of Health, Labour and Welfare (MHLW), too, has provided guidelines and other information materials to prevent those involved in decontamination works from radiation damage, and the Nuclear Disaster Victims Support Team under the Cabinet Office has also drawn up "Decontamination Technology Catalog," which summarizes effective technologies for decontamination. In addition, MOE has set up "Decontamination Information Plaza" as a hub for activities, such as holding of seminars on decontamination, dispatching experts into decontamination areas or other relevant areas at the request of municipalities or other communities, and gathering and transmitting the information related to decontamination volunteer activities.

Figure 1-1-10 / Basic Concept for Pushing Ahead with Decontamination Work



Source: The 19th NERH (August 26, 2011)



Source: Ministry of the Environment (September. 26, 2011)

As decontamination activities start kicking in, massive amount of removed soil and polluted waste is estimated to arise in the future. It is thus a challenge to find a way of final disposal of such waste, and to ensure and operate interim storage facilities until they can finally be disposed. Research development of

technologies for control of the amount of polluted waste, such as removed soil, as well as for capacity reduction of waste is also equally essential for the future.

As a result of widely diffused radioactive substances due to the accident, local retention of radioactive substances has been found in various areas even outside Fukushima Prefecture, and among these areas, there are a number of spots where level of radiation dose detected was higher than that of surrounding areas[1]. Furthermore, it has also been found that high density of radioactive pollution can occur under certain conditions even in areas, where air dose rate is relatively low. For further detection of high-dose spots, MOE suggests prompt and adequate responses by providing clear information to local governments and making guidelines regarding a series of studies including measures after detection.

e) Securing Food Safety

Due to the nuclear power plant accident, radiation exceeding provisional regulation values was detected in tap water and some food products, and restrictive measures were accordingly taken on shipping and cropping. In different case, radioactive substance was found from beef cattle in another area fed with contaminated rice straw. As a result of these incidents, public concern and interest for food safety escalated. To tackle such problems, MHLW, MAFF, the Consumer Affairs Agency, other ministries and agencies concerned as well as local governments have started taking measures such as strengthening food inspection, restricting shipment of agricultural crops exceeding the set standard, and supporting upgrades of testing equipment. Concerned ministries and agencies have also been holding briefing sessions and other presentations regarding protection measures against radioactive substances in food, and publicizing a variety of FAQs to deepen producer and consumer understanding. With regard to school meals, too, MEXT subsidizes upgrading of testing equipment to inspect cooking ingredients for 17 prefectures in eastern Japan.

It is of utter importance to ensure safety and security of food. MHLW, therefore, started working towards the review on regulation values of radioactive cesium contained in food through the discussions at the Pharmaceutical Affairs and Food Sanitation Council. They presented new standard values to the MEXT's Radiation Council, set it based on the response from the Council, and put into effect on April 1, 2012 (transitional measures applied to some items) (Figure 1-1-11). Further efforts for safety and security of food must be made to effectively implement the necessary measures, along with risk communication described further.

[1] On October 21, 2011, the Team in charge of assisting the lives of disaster victims, MEXT and MOE called these spots "spots where a spatial dose rate at 1 meter above the surface can be measured 1 mSv/hour more than that of the surrounding area," and decided to regard them as an indication for decontamination.

Figure 1-1-11 / New Standard Limits of Radioactive Cesium contained in Food

○ Provisional regulation values for radioactive cesium*1

Food categories	Value
Drinking water	200
Milk, diary products	200
Vegetables	500
Grains	
Meet, eggs, fish etc.	

*1 Implementation of regulation values including radioactive strontium

○ New standard limits for radioactive cesium*2

Food categories	Limit
Drinking water	10
Milk	50
General food items	100
Foods for babies	50

(unit: becquerels per kilogram)

*2 Implementation of standards limits including radioactive materials such as strontium and plutonium.

Source: Created by MHLW

f) Risk Communication

As for progress, damage and effect of the accident, it must also be recognized that information was not accurately delivered at the right time. The June Report to the IAEA refers to the communication problems regarding the accident as below;

- "Communication to residents in the surrounding area was difficult because communication tools were damaged by the large-scale earthquake. The subsequent information to residents in the surrounding area and local governments was not always provided in a timely manner."

"The impact of radioactive materials on health and the radiological protection guidelines of the ICRP, which are the most important information for residents in the surrounding area and others, were not sufficiently explained."

"Japan (martially omitted) has not sufficiently presented future outlooks on risk factors, which sometimes gave rise to concerns about future prospects."

The interim report of the government's investigation also pointed out the problem with the way the government provided information to the public, stating; "In the case under investigation, the evident tendency was to be slow in communicating and disclosing urgent information, holding back on press releases, and giving vague explanations, and this type of risk communication during an emergency cannot be regarded as acceptable, regardless of the situation."

In "Report: Working Group on Risk Management of Low-dose Radiation Exposure" mentioned earlier, the risk communication at the time of the accident is pointed out as follows: "The fact that experts opinions varied with regard to safety and the danger and health effects from radiation when expressed by the mass media and others led to feelings of uncertainty and unease on the part of the local area residents and thereby invited chaos. With reflection on this situation, factors now considered to be of crucial importance are review of the scientific findings obtained to date and provision of such information to local residents in a format that ensures ready understanding of risk assessment consistent with the ongoing situation in Fukushima. Based on these efforts, it is necessary to ensure that residents

are able to handle such situations on their own if necessary, based on accurate understanding of radiation and radioactivity." On April 19, 2011, for instance, when the NERH drew up "Provisional view regarding the judgment of the use of schoolyards and educational facilities in Fukushima Prefecture," a debate broke out over the validity of the standard among media, experts, even members of the Diet at various locations. In this instance, ICRP's concept that the level of radiation protection different from the ordinary level can be applied at times of nuclear emergency or of restoration did not seem to be accepted easily, either.

Since the nuclear accident, a series of events reflecting the spread of public fear about radiation and radioactivity have taken place. At the traditional ceremonies, there was a plan to burn wrecked pine trees from tsunami-hit areas, but the implementation of the plan was disrupted by the voices of concern about radiation contamination. In other cases, display of fireworks made in Fukushima was canceled due to fear about radiation contamination, and installation of a bridge girder constructed in Fukushima was interrupted by protest from local residents fearing contamination. Moreover, some neighboring locals asked those parents, who evacuated from Fukushima area, not to let their children play around in a local park, and people driving Fukushima-registered vehicles were subject to harassment from locals. In addition, wide-area disposal procedure of disaster waste came to a standstill because of the residents' concerns about receiving radiation-contaminated waste.

According to a report by Fukushima Prefecture in the end of March 2012, on the other hand, it was confirmed that radiation dose on children was steadily suppressed to a low level at all school facilities open in Fukushima, buy about 20% of public schools restricted children from outside activities in May the same year.

Concerns of radiation effects on human body were heard not only from residents near the TEPCO Fukushima NPS, but from across the country. MEXT has set up "Health Counseling Hotline" in cooperation with agencies such as the JAEA and National institute of Radiological Sciences (NIRS) to provide consultations. JAEA has started holding "Meeting to answer the questions on Radioactivity" by researchers and technical experts for guardians of children as well as teachers of Fukushima Prefecture, and many university researchers and non-profit organizations took measures as a response to people's interest and fear of radioactivity.

In addition, information transmission by experts, activities such as information communication and information sharing between users were also actively undertaken online and through social media. The nuclear accident has thus presented to us a major challenge for the future on how to provide the public with specific information accurately and promptly, and especially how to respond to people's questions and concerns with their trust, under a situation where experts express different views on certain issues.

g) Response for Mitigating the Effects of NPS Accident and Decommissioning of the Fukushima Daiichi NPS

On April 17, 2011, regarding the restoration from the accident, TEPCO announced "Roadmap towards Restoration from the Accident at Fukushima Daiichi Nuclear Power Station," in which its gradual restoration targets and target dates are set. The Japanese government and TEPCO have so far advanced the approach collaboratively, while monitoring and releasing the progress status regularly and making reviews on certain issues according to the progress. (Figure 1-1-12)

Figure 1-1-12 / Roadmap towards Restoration from the Accident at Fukushima Daiichi Nuclear Power Station

	Step 1 (approx. 3 months)	Step 2 (6-9 months from present)
Target	Steadily decrease radiation dose	Control and considerably inhibit radiation dose
Nuclear reactor	Maintain stable cooling (with water)	Achieve cold shutdown condition
Fuel pools	Maintain stable cooling	Maintain stable water level (by remote operation)
Contaminated water	Prevent from leaking out	Sufficiently dispose of and reduce contaminated water
Contaminated air and soil	Prevent from scattering around	Cover entire buildings

Source: Created by METI

In working for restoration from the accident, under incidents beyond assumptions, however, equipment and personnel prepared prior to the accident alone often could not deal with the restoration works. Therefore, the works have been conducted with the assistance of various agencies such as the Self Defense Forces, the police and fire department on, for example, spraying water by water canon trucks or pouring water from helicopters. In addition to the assistance from domestic agencies, international agencies as well as many other countries have also supplied many support services such as dispatching experts, providing water-canon vehicles or protective clothing.

A robot designed to operate for nuclear disaster response was sent in to work under high level of radiation, but it was in trouble at the site in some cases due to lack of practical experience in operation and other reasons. It is now, therefore, imperative to establish a technology and system available for practical use of robots.

As for "Roadmap towards Restoration from the Accident at Fukushima Daiichi Nuclear Power Station," it was confirmed on July 16, 2011, that targets set in Step 1 were achieved. Likewise, on December 16, targets in Step 2 were also confirmed achieved when the reactors were brought to "cold shutdown condition" and became capable of maintaining a state of sufficiently-low exposure dose within the site boundaries even in case of unexpected trouble. As a result, the government of Japan and TEPCO decided to take, along with efforts to maintain stabilization of the plant, mid-to-long-term necessary measures toward decommissioning of the reactors such as removing fuel from spent fuel pool of Unit 1 to 4, taking fuel debris[1] out of reactor pressure vessel as well as reactor containment vessel of Unit 1 to 3[2]. On December 21, 2011, "Mid-and-Long-Term Roadmap towards the Decommissioning of Fukushima Daiichi Nuclear Power Station Unit 1-4, TEPCO" was thereby finalized at Government and TEPCO's

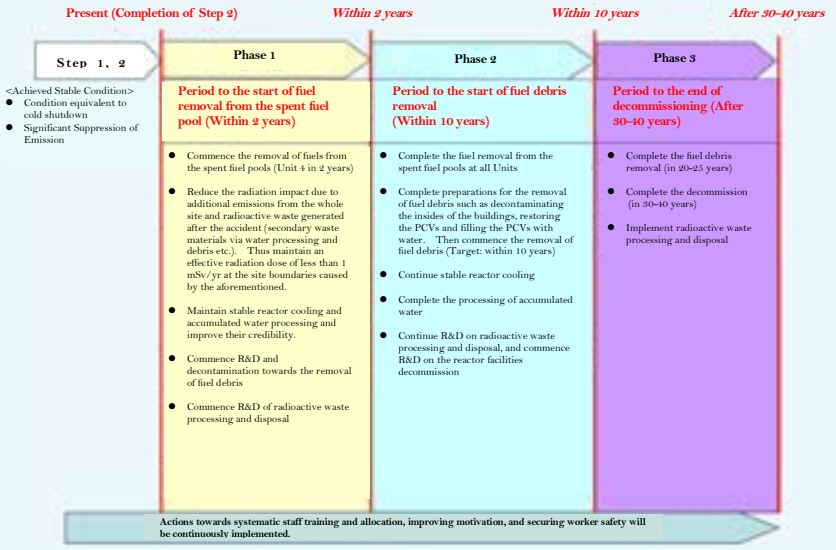
[1] substances of which fuel and cladding tubes have been fused then re-solidified

[2] The Chernobyl nuclear power plant used stones to contain radioactive materials, which is known as "stone coffin containment," but it requires a perpetual management in order to prevent the materials from leaking due to the aged structural integrity of the coffin. By taking out fuel rods, reprocessing them, and dismantling reactors, the Fukushima plant aimed to reduce the risks and costs it might have to take.

Mid-to-Long Term Countermeasure Meeting.

The roadmap divides the period to the end of decommissioning into 3 phases. Tasks to achieve in each phase are indicated, and schedules of primary on-site works, R&D projects, etc. planned to be carried out are also provided as specifically as possible (Figure 1-1-13).

Figure 1-1-13 / Summary of Mid-and-Long-Term Roadmap towards the Decommissioning of Fukushima Daiichi Nuclear Power Station, Unit 1-4, TEPCO



Source: Excerpted from Government and TEPCO's 1st Mid-to-Long-Term Countermeasure Meeting (Dec. 21, 2011)

Furthermore, "Research and Development Roadmap for Decommissioning Units 1-4 at TEPCO Fukushima Daiichi Nuclear Power Station" has outlined major R&D projects for the days to come (Figure 1-1-14). Based on this roadmap, the Government of Japan, TEPCO, JAEA, and other related manufacturing companies are, in coordination and cooperation with each other, currently proceeding with necessary R&D projects. JAEA, for instance, has thus far made efforts, in cooperation with TEPCO and other manufacturers, to ascertain the characteristics of substances such as waste zeolite for long-term storage as well as creation of waste form, acquire chemical and physical characteristics data using simulated fuel debris, and assess material corrosion behaviors under radiation/seawater environment.

Figure 1-1-14 / Research and Development Roadmap for Decommissioning units 1-4 at TEPCO Fukushima Daiichi Nuclear Power Station (R&D projects)

(1) R&D related to the removal of fuel from spent fuel pool

- Evaluation of the Long-term Integrity of Fuel Assemblies Removed from the Spent Fuel Pool (FY 2011-2015)
- Evaluation of the Long-term Integrity of Fuel Assemblies Removed from the Spent Fuel Pool (FY 2013-2017)

(2) R&D related to preparation for removal of fuel debris

① Fuel debris removal using remote control equipment and devices
- Development of Technologies for Remote Decontamination of the Reactor Building Interior (FY 2011-2013)
- Development of Technologies for Identifying Leak Areas in the PCV (FY 2011-2014)
- Development of PCV Repair Technologies (FY 2011-2017)
- Development of Technologies for Investigation of the PCV Interior (FY 2011-2016)
- Development of Technologies for Investigation of the RPV Interior (FY 2013-2019)
- Development of Methods and Devices for the Removal of Fuel Debris and Internal Structures in the Reactor (FY 2015-2021)
- Development of Technologies for the Containment, Transport and Storage of Reactor Fuel Debris (FY 2013-2019)
- Development of Technologies for Assessment of RPV/PCV Integrity (FY 2011-2016)
- Development of Technologies for Controlling Fuel Debris Criticality (FY 2012-2018)

② Ascertaining and analyzing reactor core status
- Further Advancement of Technologies for Analysis of Accident Progression to enable Understanding of Status of Reactor Interiors (FY 2011-2020)

③ Further Advancement of Technologies for Analysis of Accident Progression to enable Understanding of Status of Reactor Interiors
- Study of Characteristics using Simulated Fuel Debris (FY 2011-2015)
- Analysis of Properties of Actual Fuel Debris (FY 2015-2020)
- Development of Technologies for Processing of Fuel Debris (FY 2011-2020)
- Establishment of a new accountancy method for Fuel Debris (FY 2011-2020)

(3) R&D related to processing and disposal of radioactive waste

- Development of Technologies for the Processing and Disposal of Secondary Waste produced by the Treatment of Contaminated Water (2011-)
- Development of Technologies for the Processing and Disposal of Radioactive Waste (2011-)

(4) R&D into remote control equipment and devices

Source: Created by MEXT, based on Research and Development Roadmap for Decommissioning Units 1-4 at TEPCO Fukushima Daiichi Nuclear Power Station (NERH, Government and TEPCO's Mid-to-long-term Countermeasure Meeting, December 21, 2011)

It will take such long-term approaches for the restoration from the accident and nuclear plant's decommissioning as its targeted period is set to 30-40 years from the completion of Step 2 in the roadmap. Additionally, since many of the works will come with technical difficulties never experienced before, necessary R&D will first have to be implemented, and then the collected data applied to the actual onsite works. In order to tackle such extremely rare and difficult challenges even from a world perspective, it is necessary to call upon knowledge of domestic and international experts as well as of the industrial circles, and it is also essential to develop and secure human resources capable of dealing with such challenges. These are the very missions that Japan must achieve with the power of its S&T.

h) Information Provision for the International Society

The international community has been highly concerned with the Fukushima nuclear accident in the various points such as the citizens' safety and the effects on nation's nuclear energy policy. In response to these concerns, the government of Japan submitted the June Report to IAEA at the IAEA ministerial conference in June 2011. Following this June Report, the government also presented its updated version --- "Additional Report of Japanese Government to the IAEA – The Accident at TEPCO Fukushima Nuclear Power Stations (Second Report) (hereinafter referred to as the "September Report")" at the 55th IAEA General Assembly. The September Report is concluded with the final statement as follows; "Japan has received a wide array of support from countries around the world, related international organizations, and others to date, so that Japan would like to express its deepest gratitude while also requesting continued support. Japan is working to learn everything possible from the accident while mobilizing wisdom and efforts both domestically and from around the world, and thus Japan is confident that it will be able to overcome this accident without fail."

Japan has also given an explanation about issues such as current status of and responses to each unit of the Fukushima Daiichi NPS at a number of international meetings including side-events of the Convention on Nuclear Safety 5th Review Meeting (April, 2011) co-hosted by Japan and the IAEA.

Likewise, the Prime Minister of Japan has personally provided an explanation about the conditions surrounding Japan on such occasions as Japan-China-Korea trilateral summit (May 22, 2011), G-8 summit in Deauville (May 26 and 27, 2011), United Nations High-level Meeting on Nuclear Safety and Security (September 22, 2011).

Moreover, "Briefing for the Diplomatic Corps and the Foreign-affiliated Companies in Tokyo (Diplomatic Corps Briefing)" was hosted in Tokyo from the early stages of the accident until December, 2011.

The Science Council of Japan provisionally summarized the status of the accident as well as future challenges to be dealt with, and released on May 2, 2011 the summary as an interim report to academic circles in various countries.

Japan has been working on such issues as responses to or investigations of the accident with support of the international community. In the world in which globalization is as advanced as today, it is almost impossible to contain the effects of the nuclear accident just within the country. Similarly, it is important to recognize that Japan's future responses to the accident or the damages also bear a huge impact on the rest of the world. Therefore, to carry out the consistent R&D of necessary technologies as well as to overcome the accident and the damages as quickly as possible can be described as an obligation to the international community or even a mission, for Japan to fulfill.

3) Reviewing the Nuclear Safety Regulation System

Upon the occurrence of the nuclear accident, the NISA has been performing safety evaluation based on the new procedures and rules, referring to stress test previously introduced in European countries, for improving added safety of nuclear power plants as well as of ensuring security and trust among citizens and local residents regarding safety.

As for emergency response at all nuclear plants nationwide, it will continuously be ensured that short-term measures, such as deployment of power-supply vehicles and pumper trucks, be taken

immediately, and that implementation of emergency response drills be adequately practiced. At the same time, the implementation status of mid-to-long-term measures such as the installation of seawalls will also be checked. Meanwhile, the Interim Report by the Investigation Committee on the Accident at TEPCO Fukushima Nuclear Power Stations points out about the established Off-site Center that "in the early stages of the accident under investigation it was unable to properly fulfill the role it was entrusted with." According to the report, it was because "headquarters personnel either did not assemble there, or assembled there late" because "transportation systems had been cut off or were extremely congested due to the earthquake" and "the Off-site Center did not fulfill its initially assigned role was that communications infrastructure was paralyzed because of the earthquake, monitoring posts were damaged or destroyed, roads had collapsed, electric power was unavailable, and supplies of food, water and fuel were lacking." The report also notes that "it had not been equipped with air cleaning filters to insulate it from radioactive sustain" and concludes that "The Government should take prompt actions to ensure that off-site centers are able to maintain their functions even during a major disaster."

In light of the problems caused by this accident, the government of Japan is now determined to undertake a review of regulations, framework and other issues regarding nuclear safety, in order to regain public trust in the nuclear safety administration, and improve its functions.

To be specific, from the perspectives of separation between safety regulation and utilization, and of centralization of safety regulation, the government is planning to establish "Nuclear Regulatory Agency" under MOE, implement efforts to reinforce countermeasures against major reactor accident, introduce a system that reflects the latest technical findings on facility as well as its operation, and restrict the operation period of a reactor, etc., under the revised Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors (Act No.166 of June 10, 1957). In addition, the government also intends to expand measures to prevent nuclear emergency, strengthen the authority of the NERH under emergency, implement measures for smooth restoration, and legislate the nuclear disaster prevention guidelines, etc., under the revised Act on Special Measures concerning Nuclear Emergency Preparedness. For these purposes, a bill to reform these acts has already been submitted to the Diet (as of April, 2012).

The June Report to IAEA refers to Japan's desirable future attitude toward nuclear safety, emphasizing that it is important for everyone involved with nuclear safety related work to thoroughly nurture a spirit of safety culture. To do so, according to the report, one must always make every effort to learn expertise in nuclear safety and have an attitude to willingly reflect on such issues as whether there are any safety flaws or whether there is space for safety improvement. This spirit of safety culture is a common, cross-sector factor for a series of efforts on improving and strengthening nuclear safety system over from the restoration of the accident to the future, and also, should be appropriately applied to other areas of S&T.

4) Reviewing the Energy Policies

Then Prime Minister Kan mentioned at a press conference on May 10, 2011, that he would proceed with discussions on reviewing the country's overall energy policy, and that the Basic Energy Plan needed to be reexamined from scratch and discussed.

On May 17, the government approved the "Guideline on Policy Promotion" in a Cabinet meeting, and examined "Innovative Strategy for Energy and the Environment", which also corrects the distortions and

vulnerabilities in the energy system and meets appeals for a safety and stable supply, efficiency, and for the environment at the "Council on the Realization of New Growth Strategy." To formulate the said strategy, the government decided to establish the "Energy and Environment Council" as section council under the Council.

On July 29, "Interim Compilation of Discussion Points for the Formulation of Innovative Strategy for Energy and the Environment" was decided on at the Energy and Environment Council. The interim report presented a scenario of reduced dependence on nuclear energy and a new direction for Japan's energy policy to shift toward distributed energy system. To materialize these objectives, the report continued, Japan must reflect on its mass energy consumption structure, review the Basic Energy Plan from scratch, and encourage nationwide discussions to aim for a best-mix of energy sources and energy systems evidenced with new technology schemes.

The Energy and Environment Council will also, based on the basic principles decided at the council on December 21, compile a draft proposal of options for nuclear energy policies, energy mix and domestic countermeasures against global warming, which the relevant meeting structure including the Japan Atomic Energy Commission (JAEC), the Advisory Committee for Natural Resources and Energy and the Central Environmental Council is designated to develop. The Council will then present a unified set of multiple strategy-related options, promote national discussions, and aim to finalize the Innovative Strategy for Energy and the Environment in summer of 2012.

In light of the accident at TEPCO Fukushima NPS, discussions over the issues such as improvement of nuclear safety and review of nuclear policies were generated overseas. For instance, there were movements toward ensuring nuclear safety in the United States, France or Spain, and movements toward reviewing country's nuclear energy policies in Germany, Italy or Switzerland. (Table 1-1-15)

Table 1-1-15 / Nuclear Policies in Foreign Nations Post Accident in Fukushima

	Status of Nuclear Policies and Plans	Notes
France	○ Will focus on the expansion of reactors' service life with safety performance enhanced for the time being. ○ On April, 2011, the President Sarkozy stated that there are no alternative energy sources but nuclear at this point, and that this issue should be debated not from the viewpoint of whether you agree or disagree but from its safeness.	• 58 in operation, 3 under construction/being planned
Germany	○ Decided to gradually shut down all nuclear power plants by 2022 in June, 2011.	• 9 in operation, 0 under construction/being planned
Italy	○ Decided to cancel nuclear energy introduction plant with the result of public referendum.	• 0 in operation, 0 under construction/being planned
Russia	○ Sergey Vladilenovich Kirienko, Director General, State Atomic Energy Corporation "ROSATOM," spoke, at the IAEA Ministerial Meeting in June, 2011, that he would continue to use atomic energy, in light of lessons learned from the disaster in Fukushima.	• 32 in operation, 54 under construction/being planned
Spain	○ With policy to move away from nuclear energy, the previous administration decided to closed down the Garona Nuclear Power Plant. However, soon after the People's Party won the general election and became a ruling party, they requested the Nuclear Safety Commission for safety performance test on the Garona plant in the hope of expanding the deadline toward its shutdown.	• 8 in operation, 0 under construction/being planned
Switzerland	○ Parliament decided to cancel construction of new nuclear plants (gradual withdrawal from nuclear energy without replacing existing plants)	• 5 in operation, 0 under construction/being planned
Ukraine	○ 15 Russian-model nuclear plants in operation. Construction plan of another 2 reactors aiming to start operation in 2015-2016.	• 15 in operation, 13 under construction/being planned
UK	○ Government concluded, in Nuclear White Paper (2008), that building another nuclear power plants would eventually help achieve the goals regarding climates change and energy security of UK. ○ Planning to shut down 18 plants except PWR1 by 2023. ○ Announced 8 potential locations for the construction of new plants by 2025 in June, 2011.	• 19 in operation, 4 under construction/being planned
Canada	○ No movements for the review of nuclear energy policy seen at present.	• 17 in operation, 9 under construction/being planned
US	○ In March, 2011, the President Obama made a statement that nuclear power was an important energy source against global warming (presidential statement on energy security). ○ Request for construction project of 19 new plants is now under review, waiting to be approved by the U.S. regulatory authorities.	• 104 in operation, 35 under construction/being planned
China	○ Expresses its stance toward nuclear energy that it is still one of the remaining options to tackle the problems of power shortage and global warming. ○ Medium to long term development plan for China's nuclear sector (2007) refers to its possible target for 40 gigawatts of nuclear-generating capacity by 2020.	• 14 in operation, 57 under construction/being planned
S. Korea	○ Announced the 4th Atomic Power Development Plan (2011), which presented its national policy to aim for a world exporter of atomic energy. Planning to build 6 more domestic plants by 2016.	• 21 in operation, 11 under construction/being planned

Source: Created by MEXT, based on 9th Fundamental Issues Subcommittee of Advisory Committee for Natural Resources and Energy (January 24, 2012)

In addition to the efforts described in the above figure, the United States set up a task force after the disaster in Fukushima, and made recommendations for enhancing reactor safety to the U.S. Nuclear Regulatory Commission (NRC) in July 2011. Furthermore, NRC, for the first time after the Three Mile Island Nuclear Power Plant Accident, officially approved the construction and operation of new nuclear power plants in February 2012. Germany, on the other hand, decided in June 2011, to gradually shut down all nuclear power plants by the end of 2022. Italy also decided to discontinue the introduction of nuclear power generation upon the result of a public referendum.

The nuclear accident in Fukushima has had an impact not only on the review of nuclear energy's place within Japan's energy policies, but also on the discussions over nuclear energy policy in other countries. It is thus important to incorporate a wide range of opinions from all levels of people into how we should proceed with R&D of new technologies that have a tremendous social impact. In doing so, however, whether or not experts can present risks and benefits of new technologies based on scientific evaluation to the public in the simplest way, or whether they can ensure the reliability of the evaluation, will be one of the deciding factors in moving the discussion forward effectively.