Issues and Recommendations Associated with Radiation Protection after Fukushima Daiichi Nuclear Power Plant Disaster

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Japan Health Physics Society

CONTENTS

1. Introduction

1.1 Objective

Soon after the Fukushima Daiichi nuclear disaster following the Great East Japan Earthquake and subsequent tsunami, Japan Health Physics Society (JHPS) established a Q&A section on our website and answered questions from the public in our capacity as a group of radiation protection experts. In addition, we held symposia on measures for dealing with the nuclear disaster and their criteria on 16 June 2011 and on exposure to radiation among the general public on 12 August 2011. We also held a session on the Fukushima Daiichi nuclear disaster at the 44th JHPS Annual Meeting on 18 October 2011 to deepen understanding and promote discussion about various topics related to the disaster. On 17 December 2011, we also held a comprehensive symposium on measures for dealing with the Fukushima nuclear disaster from the viewpoints of radiation exposure assessment and radioactive waste management, focusing on internal exposure, to comprehensively discuss the Society's activities carried out over the year following the earthquake. After online consultation with the JHPS members over a period of about one month, we completed a report of the first set of recommendations entitled "Issues Associated with Radiation Protection after Fukushima Daiichi Nuclear Power Plant Disaster - Responses of and Recommendations from Japan Health Physics Society -" (the first JHPS recommendations) and released it to the domestic society on 17 April 2012. This first report was translated into English and presented at the 13th International Congress of the International Radiological Protection Association (IRPA13); it was the JHPS statement to the international academic society (See Fig. 1.1.1). In the final remark in the first recommendation report, there is the message "We will endeavor to further the study of health physics and radiation protection through future discussion and provide useful references for local residents and administrative organizations. In the near future, we will carefully analyze the actual state of the Fukushima area to propose recommendations in cooperation with overseas associated societies such as the Asian and Oceanic Association for Radiation Protection (AOARP), the International Radiation Protection Association (IRPA), and the Health Physics Society in the US."

During the 2012 fiscal year, investigative reports were released by the Investigation Committee on the Accident at the Fukushima Nuclear Power Stations of Tokyo Electric Power Company (Governmental Final Report, 23 July 2012; Interim Report, 26 December 2011), the National Diet of Japan Fukushima Nuclear Accident Independent Investigation Commission (National Diet Report, 5 July 2012), the Independent Investigation Commission on the Fukushima Nuclear Accident (Nongovernmental Report, 27 February 2012), and the Tokyo Electric Power Company (TEPCO report, 20 June 2012). These reports have clarified the facts of the accident, and recommendations were made towards the prevention of recurrence and minimization of the damage. However, some knowledgeable person pointed out the necessity of reviewing these investigative reports from the viewpoint of an expert in the field of radiological protection, which is the foundation of our societies' existence, because radiological protection experts did not fully engage in the investigative committees.

Moreover, in section 2 "Recapitulation of Major Issues" in chapter VI "Wrap-up and Recommendations", it is recommended that "The government, nuclear operators, nuclear plant manufacturers, research institutions, academies, and all such stakeholders (relevant organizations) involved in nuclear power generation should take active roles in investigating the accident and in fact analyses, and continue, in their respective capacities, their

comprehensive and thorough investigations of the remaining unresolved problems." In this sense, JHPS, involving many radiological protection experts, has a responsibility to continue making recommendations associated with radiological protection related to the Fukushima Daiichi nuclear disaster.

Under such circumstances, JHPS established a new project for making comprehensive recommendations on radiological protection, and decided to review how radiological protection measures after an accident should be carried out on the basis of concrete facts clearly described in the investigative reports and opinions collected at the JHPS symposia, and in elaborate comprehensive reports on the second set of recommendations encompassing the first set of recommendations.

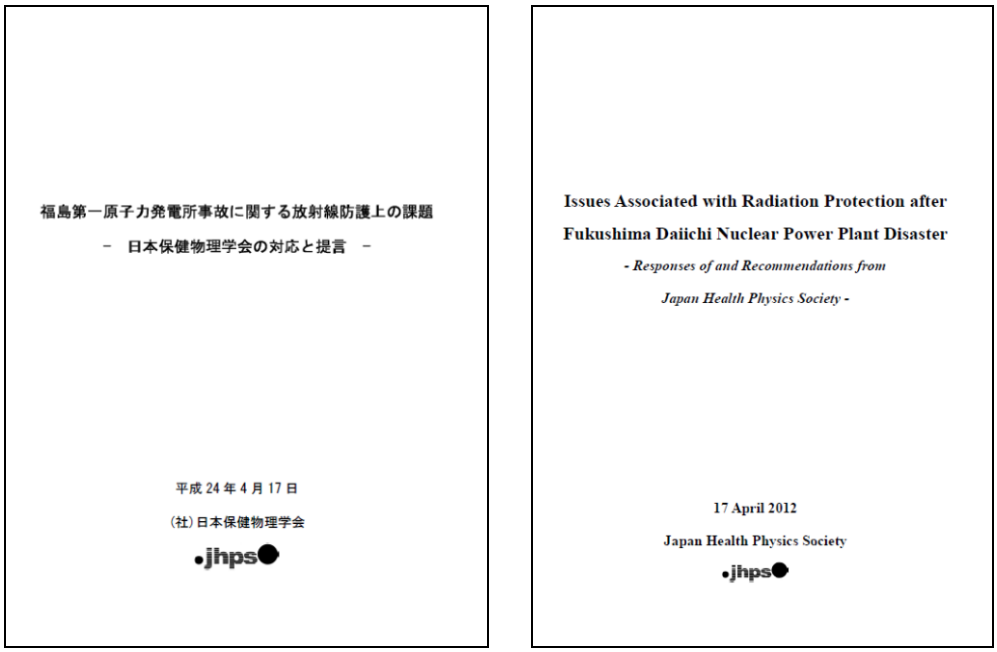

Fig. 1.1.1 Issues Associated with Radiation Protection after Fukushima Daiichi Nuclear Power Plant Disaster - Responses of and Recommendations from Japan Health Physics Society - (The first set of recommendations)

1.2 Fundamental policy in the elaboration of recommendations

In the elaboration of the recommendations, emphasis was placed on the viewpoint of how we should evolve the current radiological protection system overseeing various radiological protection measures in an emergency on the basis of concrete facts clarified from investigative reports and the JHPS symposia. The recommendations were described so as to indicate the direction in which the radiological protection system should move toward in the future, utilizing JHPS's connections with many radiological protection experts.

JHPS is the only Japanese association that participates in the International Radiological Protection Association (IRPA). JHPS must not monopolize the contents of the recommendations within Japan and has the responsibility to continuously strive to share the recommendations with radiological protection experts overseas. For this reason, we decided to elaborate the second set of recommendations on the assumption that JHPS will translate the second set of recommendations into English in the same way as the first set and disclose the

recommendations to the world.

On the basis of the above policies, the second set of recommendations were elaborated keeping in mind that the recommendations are not only for the Japanese government, regulatory organizations and specific experts in radiological protection; they must also be understood by experts worldwide from each standpoint and be able to be utilized independently. For this reason, we constructed this report in the following manner. Chapter 2 includes issues identified by referring to and reviewing investigative reports and summarizes various radiological protection measures to be implemented in an emergency so that experts overseas can correctly understand concrete facts with regard to responses after the accident. Chapter 3 includes recommendations related to radiological protection for the public and workers. Chapter 4 contains the final remarks.

2. Review of responses after accident from the viewpoint of radiological protection

2.1 Review on basis of investigative reports, etc.

In this report, the following investigative reports are reviewed. Please note that we have translated the Nongovernmental Report into English, as it was originally published in Japanese only.

- Investigation Committee on the Accident at the Fukushima Nuclear Power Stations of Tokyo Electric Power Company, Interim Report, 26 December 2011, **[Governmental Interim Report]** [1)]
- Investigation Committee on the Accident at the Fukushima Nuclear Power Stations of Tokyo Electric Power Company, Final Report, 23 July 2012, **[Governmental Final Report]** [2)]
- National Diet of Japan Fukushima Nuclear Accident Independent Investigation Commission, Report, 5 July 2012, **[National Diet Report]** [3)]
- Independent Investigation Commission on the Fukushima Nuclear Accident, Report, 27 February 2012, **[Nongovernmental Report]** [4)]
- Tokyo Electric Power Company, Fukushima Nuclear Accident Analysis Report, 20 June 2012, **[TEPCO Report]** [5)].

Regarding “dose estimation results due to intake of foods” and “external dose assessment using personal dosimeters” that are not involved in the above 5 reports, the following information in Japanese is referred to. Please note that we have translated the Nongovernmental Report into English, as it was originally published in Japanese only.

- Estimation of radiation exposure due to intake of foods (in Japanese), 30 October 2011, **[the Ministry of Health, Labour and Welfare (MHLW) HP (30 Oct. 2011)]** [6)]
- Measurement results of amount of intake of radioactive materials from foods (in Japanese), 11 March 2013, **[MHLW HP (11 Mar. 2013)]** [7)]
- Fukushima Health Management Survey (in Japanese), the 1st meeting of the study team on health effects on the residents from the Fukushima Daiichi Nuclear Accident, 30 November 2012, **[Nuclear Regulation Authority (NRA) HP]** [8)]
- Exposure dose obtained in the present stage (in Japanese), 26 April 2012 **[Fukushima Prefecture HP]** [9)]
- Measurement results of personal dosimeters (glass badge) (in Japanese), 17 January 2012 **[Fukushima city HP]** [10)]

The cited parts associated with concrete facts from investigative reports are described below in small font in the order of the above five investigative reports. The source of citation is indicated by the abbreviation in brackets **[ ]**. Important parts of the concrete facts in relation to the radiological protection related issues are underlined.

(1) Environmental radiation monitoring

Radiation monitoring data obtained after a nuclear accident provides significant information for designating evacuation areas to restrict radiation exposure of residents and areas, from which to restrict food, beverages, and the shipment of agricultural products, and for estimating the amount of discharged radioactive materials to understand the details of the accident. The aim of radiation monitoring after a nuclear accident can be categorized into land area monitoring (including aircraft monitoring of air radiation dose rates at a height of 1 m from ground level and the accumulation of radioactivity in the land surface, and monitoring of tap water and food) and coastal sea area monitoring. The daily monitoring of inhabited areas is a significant target of disaster measures. Coastal sea area monitoring, however, became an important target of radiation monitoring after the Great East Japan Earthquake and subsequent tsunami, since the Fukushima Dai-ichi Nuclear Power Station (NPS) faces the sea, most of the radioactivity released into the air fell into the sea, water contaminated with a high level of radioactive materials was discharged through cracks in the concrete, and approximately ten thousand tons of water contaminated with a high level of radioactive materials was intentionally discharged into the sea to free up storage space for high-level contaminated water. An overview of how the radiation monitoring was carried out and the issues identified are described below.

(a) Radiation monitoring on land

- Measurements of ambient dose rate, airborne dust, environmental samples and soils, and aircraft monitoring

Descriptions about measurements of ambient dose rate, airborne dust, environmental samples and soils are given in **[Governmental Interim Report]** and **[National Diet Report]** in the following way.

a. Role sharing among the central government, local governments, and nuclear power operators before the accident occurred

The “Basic Disaster Prevention Plans” created by the Central Disaster Management Council stipulates that the radiation monitoring at the nuclear disaster should be undertaken by local governments; and that the Ministry of Education, Culture, Sports, Science and Technology (hereinafter referred to as "MEXT"), operators, and designated public institutions including the National Institute of Radiological Sciences (hereinafter referred to as "NIRS") and Japan Atomic Energy Agency (JAEA), should support the emergency monitoring of local governments by mobilizing both a mandatory emergency monitoring workforce and all necessary equipment to disaster-stricken areas.

According to the "Nuclear Emergency Response Manual" (hereinafter referred to as the "NE Response Manual", after the declaration of a nuclear emergency, a radiation monitoring team from the Nuclear Emergency Response Local Headquarters (“Local NERHQ”) of Japanese Government should collect and arrange radiation monitoring data. Such data will provide the basis for establishing which areas will be evacuated of all residents, as well as determining where the consumption of food and drink by the residents is to be restricted or forbidden. Moreover, the NE Response Manual stipulates that if a nuclear accident has occurred at a commercial reactor, the local NERHQ should provide a comprehensive summary of all monitoring data to the Secretariat of the Nuclear Emergency Response Headquarters (hereinafter referred to as the "METI-NERHQ), which is located at the Emergency Response Center (ERC) of the Ministry of Economy, Trade and Industry (“MITI”), and that the NERHQ Secretariat should provide this data

to the Cabinet Secretariat of the Nuclear Safety Commission (hereinafter referred to as the "NSC"), as well as all other designated administrative agencies.

The Fukushima regional disaster prevention plan stipulates that the Fukushima prefectural government should implement monitoring tasks even during normal times, that they should make provisions to take swift countermeasures if they receive a report of any unusual state of affairs based on the Act on Special Measures Concerning Nuclear Emergency Preparedness, and that they should make an effort to be well-positioned to implement emergency monitoring. This includes the need to work out a radiation monitoring strategy, prepare and maintain radiation monitoring facilities and equipment, secure all required radiation monitoring personnel, and ensure cooperation among relevant organizations.

The Fukushima prefectural government has monitoring posts established in twenty-four locations based on the Fukushima regional disaster prevention plan. Moreover, the Fukushima prefectural government constantly observes the radiation levels in the surrounding areas of the nuclear power station, which are measured through the monitoring posts operated by Environmental Radioactivity Monitoring Centre (hereinafter referred to as the "Monitoring Center"), which is adjacent to the emergency preparedness and response center (hereinafter referred to as the "Off-site Center"). The prefectural government has a total of thirteen monitoring cars for all relevant organizations including the off-site center. In addition, the local government's analytical equipment includes four germanium semiconductor detectors as well as NaI scintillation detectors located within the Monitoring Center.

Concerning nuclear operators' roles in monitoring, the Basic Disaster Prevention Plans stipulates that nuclear operators should prepare and maintain all the required measuring equipment (for each nuclear operator's facility), including site border monitoring posts, portable type measuring instruments and stack monitors in order to ensure that monitoring results are reported accurately when a specific incident occurs, and that nuclear operators should continue monitoring at site borders in order to notify the Nuclear Emergency Response Local Headquarters of any monitoring results.

Based on this stipulation, the Nuclear Operator Emergency Action Plan" of the Tokyo Electric Power Company (hereinafter referred to as "TEPCO") stipulates that the health physics team of the Emergency Response Center, which is to be established at the Emergency Response Control Room in the Seismic Isolation Building of the power station, should be in charge of monitoring activities if an accident occurs at either the TEPCO Fukushima Dai-ichi Nuclear Power Station (hereinafter referred to as the "Fukushima Dai-ichi NPS") or the TEPCO Fukushima Dai-ni Nuclear Power Station (hereinafter referred to as the "Fukushima Dai-ni NPS"). With regard to monitoring equipment, TEPCO has eight monitoring posts, 14 stack monitors (two stack monitors for each stack), six liquid discharge monitors, and one monitoring car (located at the Fukushima Dai-ichi NPS).

Government's NE response manual stipulates that the monitoring data collected by the Local NERHQ is to be released to the public. The Local NERHQ radiation monitoring team shall create press releases on emergency monitoring for press conferences. The Local NERHQ public relations team shall deal with the press and all PR presentations and answer reporters' questions, while maintaining close contact and cooperation with the Local NERHQ administrative team, the Secretariat of the NERHQ and the PR groups of the emergency response headquarters of various local governments. In addition, TEPCO shall publish all data collected through the monitoring posts and stack monitors installed in each power station on its homepage.

This section mainly describes monitoring activities concerning the decisions the Government makes to limit the extent of any hazards.

b. The primary monitoring activities that were conducted outside the premises of the Fukushima Dai-ichi NPS after the accident

As a result of the earthquake and the ensuing tsunami damage, 23 of the 24 monitoring posts the Fukushima government had installed in the prefecture were rendered inoperative, the sole exception being the one installed at Ono station. In addition, due to severe earthquake damage,

two of the four germanium semiconductor detectors that had been installed at the Monitoring Center were rendered inoperative.

The Fukushima prefectural government discussed the possibility of monitoring being conducted via monitoring cars starting on March 11, 2011. They determined, however, that it might be too risky to conduct monitoring at night with caved-in roads and widespread power failure. Instead, they started the monitoring early in the morning of March 12, 2011.

Also, following the nuclear accident on March 11, 2011, the Ministry of Education, Culture, Sports, Science and Technology decided to dispatch monitoring cars to the Off-site Center, pursuant to the National Basic Disaster Prevention Plans. However, it was sometime late in the evening of March 12 that they actually issued directions for their dispatch. It was around 11:20 the next day on March 13 that their professional support members arrived at the Monitoring Center.

From March 13, staff from the Fukushima local government as well as the national government used the monitoring cars, working together to conduct monitoring activities such as measuring radiation doses in the air, collecting dust suspended in the atmosphere, environment samples and soil samples based on the radiation monitoring strategy developed by the staff of the Monitoring Center and accepted by the Local Emergency Response Headquarters (Local NERHQ). The collected samples were analyzed using the two germanium semiconductor detectors, located at the Monitoring Center. The results of the analysis were reported to the Local NERHQ located at the adjacent off-site center.

The initial monitoring activities did not work out as intended due to a host of reasons including hazardous road conditions from earthquake damage, flat tires, vehicles that had fallen into cracks in the ground and fuel shortages. In addition, as described in Chapter III 5(1) b5, it was difficult to consolidate the monitoring data for sharing with the Secretariat of the Government Nuclear Emergency Response Headquarters (NERHQ) and other agencies since the Off-site Center had very limited means of communication due to widespread power failure.

The Local NERHQ and the Prefectural Nuclear Emergency Response Center have played a central role in conducting monitoring activities since March 15, when the Local NERHQ that had been located at the Off-site Center, was moved to the Fukushima Prefectural Office.

[Governmental Interim Report] Chapter V 1 (1)

MEXT started to discuss monitoring by aircraft in order to do survey a wide area from around March 12 and released its "MEXT Aircraft Monitoring Action Program" on March 25. On the same day, with the cooperation of the Japan Aerospace Exploration Agency (JAXA), an independent administrative organization, the Ministry measured the levels of radiation in the air beyond 30km from the Fukushima Dai-ichi NPS. In response to a request from MEXT, the Self Defense Forces measured the concentration of radioactive materials in airborne dust particles above Fukushima Prefecture between March 24 and April 1.

In addition, the Japanese and US Governments met to start discussing how the two nations could cooperate to conduct aircraft monitoring in a U.S.-Japan conference (hereinafter referred to as the "U.S.-Japan conference"), which began around the end of March. Previously, the United States Department of Energy (DOE) had independently conducted aircraft monitoring after the nuclear accident. Two subsequent joint U.S.-Japan aircraft surveys were conducted.

[Governmental Interim Report] Chapter V 1 (2)

c. Problems in utilizing the monitored data

After the tsunami's onslaught on March 11, the loss of electric power placed the Fukushima Dai-ichi NPS in a crisis situation. The Reactor Unit 1 building explosion the next day (March 12) heightened the fears of nearby residents regarding airborne radioactive substances. In such a situation, if explanations to the resident population are to be persuasive, they absolutely must be backed up by monitored data. However, during the first five days of the emergency situation, the local NERHQ at the Off-site Center experienced a quake-induced telecommunications

breakdown, hindering its response to the monitored data. What could be done about the monitored data during this period was that the NERHQ secretariat released only some of the data it had received.

In the midst of a situation where the local NERHQ was not functioning, and when high radiation dose levels were being registered at Hirusone in Namie-machi during the night of March 15, a clear-cut delineation of roles had still not been established for evaluating those kinds of high readings and disclosing information about them. Competent personnel were at a loss on how to proceed. It was only beginning on March 16 that the Government delineated roles for the bodies responsible for monitoring data, and that the Ministry of Education, Culture, Sports, Science and Technology (MEXT) compiled and released the data to the public.

This shows how the emergency response during the initial stages of the accident was confused in its use and management of monitored data. The disclosure of obtained monitored data was especially problematic — the Government did not demonstrate a readiness to quickly disclose it, and even when a disclosure was made, only fragments of part of the information were released. Because the Chief Cabinet Secretary was giving press conferences on a regular basis on matters that included an evaluation of monitored results, the NSC did not disclose the results of monitored data assessments until March 25.

The fact that the competent authorities did not take proactive steps to disclose information on monitored results would seem to indicate a mindset that gave little priority to the lives and dignity of residents who were incurring harm and damage from the dispersion and contamination of radioactive substances, and gave little regard to the importance of disclosing data. Factors leading to these failings include: (i) local disaster readiness systems and evacuation plans had been drawn up only for form's sake, without a realistic vision of the type of situation local residents would face if a major nuclear accident were to emit large quantities of radioactive substances; and (ii) the competent authorities had no deep-seated awareness of the importance of telling residents about the various risks in the event of a major accident at a nuclear power plant, beginning with what they would desperately desire — as their need would grow for information to help them understand the situation they would find themselves in, they would want the authorities to disclose that information rapidly.

[Governmental Interim Report] Chapter VII 5

3.5.3 Fukushima's initial emergency monitoring response

Fukushima Prefecture was unable to promptly conduct emergency monitoring, as the emergency monitoring equipment was unusable. Some posts had been washed away by the tsunami and communication lines had been severed by the earthquake; only one of the 24 monitoring posts was functioning normally following the accident. The mobile monitoring posts could not be used until March 15 due to damage to the communications networks. Monitoring cars were also unavailable due to a lack of fuel.

1) The intended role of municipal governments in emergency monitoring

Data from environmental radiation monitoring is tremendously important in determining evacuation zones and providing evacuation guidance. The inability to acquire such data significantly impacted the implementation of protective measures for residents.

According to the Fukushima Prefecture regional disaster prevention plan, the prefecture is to establish and maintain monitoring posts and secure monitoring personnel. The plan states that following the declaration of a nuclear emergency situation, the prefectural government is to compile emergency monitoring results and communicate the results to personnel dispatched to the Off-site Center.

2) Inadequate initial data collection

In accordance with the Basic Plan for Emergency Preparedness and the Fukushima Prefecture regional disaster prevention plan, Fukushima Prefecture established 24 monitoring posts in the

prefecture and monitored the data at the Environmental Radioactivity Monitoring Center of Fukushima Prefecture. The prefecture also built a system for publicizing this data on its website and other channels. However, four of the 24 monitoring posts were washed away by the tsunami and another 19 were unable to transmit data due to severed communication lines. This meant that there was only one normally functioning monitoring post, making it impossible for Fukushima Prefecture and the national government to gather the necessary data from environmental radiation monitoring.

Staff from the Environmental Radioactivity Monitoring Center established two transportable monitoring posts, beginning from the early morning of March 12. However, the center was unable to collect data until March 15 due to communication failures in cellular phones used in data transmission.

The Prefectural Nuclear Emergency Response Headquarters conducted monitoring, starting in the early morning of March 12, using prefectural monitoring cars equipped with diverse data retrieval and analysis features. However, difficulties obtaining fuel halted opera-tions on March 13. When the officials withdrew from the Off-site Center on March 15, there was no choice but to leave their equipment behind, including the empty monitoring cars.

Emergency monitoring was launched in Fukushima Prefecture using emergency support personnel and equipment sent from other prefectures that were hosting nuclear power plants. The monitoring results were to be reported to the Environmental Radioactivity Monitoring Center but, as the radio signal would not reach the center from distances over 10 km, personnel had to return to a location within the signal range, hampering prompt data collection. As mentioned in 3.2.3, 3, since the prefecture was unable to secure adequate assistance from MEXT, sufficient emergency monitoring was not generally carried out in the initial response.

[National Diet Report] Chapter 3, 3.5.3

Descriptions about aircraft monitoring are given in **[Nongovernmental Report]** in the following way.

6. Aircraft monitoring was not utilized

Regarding the significantly important environmental monitoring to clarify the diffusion situation of radioactive materials, Department of Energy (DOE) of the United States analyzed the radiation dose around the Fukushima Dai-ichi NPS and disclosed the estimated values on 22 March 2011 on the basis of data obtained using a U.S. armed forces drone over more than 40 hours from 17 to 19 March and measuments on the ground. Japan had also prepared an aircraft survey system, but the first measument was not carried untill 25 March. The operation could not be done in the earlier stage?

According to “Guidance of environmental radiation monitoring”, there are some merits in aircraft monitoring, for example, “It is an effective means for determining protective measures to rapidly clarify the regions affected by the diffused radioactive plume and estimate the magnitude of the release of radioactive materials by travelling through the radioactive plume in aircraft” and “the release and diffusion of radioactive materials can be investigated in the no-entry regions rapidly and broadly avoiding excess radiation exposure of passengers by keeping a long distance from the NPS”.

The Nuclear Safety Technology Center (NUSTEC) has developed and maintained an aircraft surveillance system, and SPEEDI was operated by a team using a simplified survey system on board a helicopter that moved a team from the Self-Defense Forces from Rokkasyo village in Aomori prefecture. The simplified aircraft survey system is “for the purpose of clarifying the diffusion of radioactive materials released from a nuclear facility in the first-step monitoring that requires rapidness immediately after an accident at a nuclear facility”. “The system consists of portable equipment to measure the radiation dose rate”. “By making the system portabe, easy measurement using this system with good portability and transported as a carry-on baggage in a municipality’s helicopter for emergency use became possible without selecting a type of aircraft”.

However, the NUSTEC hurriedly traveled to Fukushima prefecture by truck since most of all helicopters were being utilized for rescue activities for the damage of the earthquake and tsunami. Finally, the date of arrival was 14 March. On 15 March, the NUSTEC went near the Fukushima Daiichi NPS by using a Self-Defense Forces helicopter with measument equipment, but there was no way except for returning. Moreover, after that, the NUSTEC unavoidably remained on standby because no helicopter could be chartered from the Self-Defense Forces owing to the great number of missions. Monitoring was started on 25 March using a helicopter chartered from a non-governmental organization and a Cessna plane chartered from the Japan Aerospace Exploration Agency (JAXA). The NUSTEC had equipment for detailed aircraft monitoring, but they had to alter the helicopter to load it. The detailed aircraft monitoring could not be carried out until the preparation was completed on 6 April.

Some people say that it was more technically difficult to use the aircraft monitoring results for the SPEEDI retrospective estimation rather than to use the monitoring results on the ground. It was simultaneously clarified that there were gaps between the United States and Japan in terms of preparedness and techniques for aircraft monitoring. Regarding the technical aspects, Mr. Hosono, the Nuclear Accident Minister, said "The aircraft monitoring system of the U.S.DOE is easier to use in the process of monitoring. The AMS [aircraft monitoring system] was used in the actual analysis, but the system for visualizing a map in the United States is more appropriate. Frankly, I think that even now, the aircraft monitoring system of the U.S.DOE is used rather than the AMS in Japan, which indicates there is a gap in the technology." The equipment for detailed monitoring in the United States could be used without altering the airplane; in contrast, that in Japan required a particular specification. For the research and development of the preparedness plan for crisis response, it is necessary to be aware of the practical use of the equipment assuming that various situations may occur in an emergency or crisis.

[Nongovernmental Report] Part 2 Chapter 5 Section 6

The following isssues can be raised in association with Radiation monitoring on land.

Radiation monitoring on land – unexpected effects on means of transportation and communication

- Radiation monitoring on land could not proceed following the previously determined emergency preparedness plan owing to unexpected effects due to road damage, widespread power failure, fuel shortages in monitoring cars, damage to communications networks, and delay in the preparation of helicopters.

Radiation monitoring on land – monitoring posts washed away and communication lines severed

- Four of the 24 monitoring posts established by Fukushima Prefecture were washed away by the tsunami and another 19 were unable to transmit data owing to severed communication lines, which resulted in 23 monitoring posts being inoperable.

- Tap-water

Descriptions about tap water monitoring are given in **[Governmental Interim Report]** and **[Nongovernmental Report]** in the following way.

f. Restriction of tap water intake

With the exception of the Index developed by the NSC (300Bq/kg for radioactive iodine and 200Bq/kg for radioactive cesium), no provisional regulation value has been defined for tap water.

On March 18 of the same year, 170Bq/kg of radioactive iodine was detected in tap water that had been collected in Fukushima-city on March 16. In response to this, the MHLW started to discuss developing criterion values for tap water just as they had for food and beverages. On March 19, the MHLW notified all municipalities of "Measures to be taken for tap water to protect citizens from radiation exposure resulting from the Fukushima Dai-ichi NPS and Fukushima Dai-ni NPS," which included: (i) refraining from drinking tap water exceeding index values indicated by the NSC (300Bq/kg of radioactive iodine, 200Bq/kg of radioactive cesium); (ii) tap water may be used for domestic use without any concern; and (iii) drinking tap water is not restricted if there is no access to alternative drinking water.

This notice did not mention drinking water for infants. Subsequently, more than 100Bq/kg of radioactive iodine was detected in tap water in Fukushima-city. On March 21, the MHLW notified municipalities to the effect that water suppliers should promptly inform citizens to refrain from providing tap water to infants if their tap water exceeded 100Bq/kg of radioactive iodine.

Additionally, the monitoring of tap water was strengthened. On March 18, MEXT notified all local governments of the "Strengthening of monitoring of environmental radioactivity levels nationwide in an emergency at the Fukushima Dai-ichi NPS and Fukushima Dai-ni NPS" to the effect that nuclide analysis of clean water (tap water) should be performed and the results should be reported to MEXT. Moreover, on March 21, the MHLW asked all local governments to provide the ministry with tap water monitoring information that had been requested by MEXT as well as any additional tap water monitoring information, if available.

Subsequently, based on the results of that monitoring, the MHLW asked municipalities to restrict the intake of tap water if their tap water supply was found to contain levels exceeding the index value.

On April 4 of the same year, based on up-to-date monitoring results, the MHLW issued a "Future monitoring policy on radioactive materials in tap water," in which monitoring policy, intake restrictions and guidelines for lifting restrictions were stipulated (this policy was revised on June 30 of the same year, based on the premise that the effects of the Fukushima Dai-ichi NPS accident were going stabilize.

[Governmental Interim Report] Chapter V 1 (1)

Water contamination and drinking restrictions

On March 15, the MHLW—noting “the necessity of imposing restrictions on the consumption of water, including drinking water”—announced to all regional governments that the Nuclear Emergency Response Headquarters would make all decisions on the matter in accordance with the Nuclear Emergency Act. In the announcement, there were guidelines for restricting food and water consumption that would serve as input for the headquarters’ decisions in establishing restrictions. On March 18, MEXT requested that all regional governments test the tap water in their localities and report the results to MHLW for purposes of assessing the progress of monitoring activities in various regions. On March 19, regarding the monitoring results of the tap water found to exceed the guideline level for restricting food and water consumption, MEXT issued the following notification: (1) Consumption of water found to exceed guidelines should be reduced. (2) Using this water for other purposes in daily life is not problematic. (3) In the absence of any alternative source of drinking water, the water may be consumed.

Announcements of actual consumption restrictions were made by local water bureaus in city and regional governments. For example, in Tokyo water restrictions were imposed between March 23 and 24, and in the town of Iitatemura in Fukushima Prefecture water restrictions were

in place between March 21 and April 1 (and until May 9 for nursing infants).

(Omission)

3. Examples of the detection of radioactive material in tap water exceeding the regulatory value (Tokyo and Fukushima)

This example is about the intake of tap water where radioactive materials are detected beyond the regulatory value. Regardng tap water, the government or municipality cannot take enforced action on behalf of consumers, which is different from the case of the above-mentioned agricultural and livestock products. Therfore, the final judgment on whether or not to drink tap water is left to the individual including a balance among the other health risks. The contamination of tap water and the restriction of intake have already been mentioned above. The two findings in the Tokyo Metropolitan area and Iidate village in Fukushima prefecture are described below.

The Waterworks Bureau in the Tokyo Metropolitan area announced on 23 March that radioactive iodine 131 was measured at 9 o'clock on 22 March in the Kanamachi filtration plant exceeding the temporary regulation value for tap water for an infant (The measured value was 210 Bq/kg, the temporary regulation value for infants was 100 Bq/kg). Simultaneously, they issued advice to refrain from providing tap water to infants in the region of the twenty-three wards of Tokyo and the Tama area. On 24 March, they announced that it was safe to provide tap water to infants because the concentration decreased to 79 Bq/kg, which was below the regulation value.

Meanwhile, since bottled water could not be obtained in many areas, there were severe cases in which people ultimately had to decide for themselves whether to drink tap water including radioactive materials or to refrain from drinking water and whether or not to continue breast feeding out of concern regarding the transfer of radioactive materials from mother to child. The Tokyo Metropolitan area distributed 240,000 plastic bottles of water to the regions affected by the notification to refrain from drinking tap water (especially for families with infants).

Government and scientific society announced their views and technical advices on the intake of tap water by infants and pregnant women. In an announcement from the MHLW on 21 March, to refrain from drinking tap water when the radioactivity level exceeded the temporary regulation level unless alternative drinks could be ensured. On 24 March, three scientific societies (Japan Pediatric Society, Japan Society of Perinatal and Neonatal Medicine, and Japan Society for Premature and Newborn Medicine) provided advice on the hazards of providing mineral water to infants and refraining from drinking water in comparison with the dangerousness of radiation in a joint statement. On the same day, in the presentation of the Japan Society of Obstetrics and Gynecology, pregnant women were cautioned regarding the risk of refraining from drinking water.

The radioactivity concentration in each filtration plant including Kanamachi gradually decreased after 25 March. From early April, the concentration in every filtration plant was continuously less than the lower detection limit (the lower detection limit differs from place to place, but is approximately 1 Bq/kg).

Next, the case of Iidate village in Fukushima prefecture is described below. On 21 March, Iidate village in Fukushima prefecture announced that 965 Bq/kg of radioactive iodine was detected in tap water (the date of the sampling was 20 March). This value exceeded the temporary regulation value of 300 Bq/kg (100 Bq/kg for infants). In response to this, Iidate village residents were instructed to refrain from drinking tap water. After that, the measured value decreased. In the inspection results announced on 2 April and sampled on 28 March, the radioactivity concentrations in all three filtration plants (Hanatsuka, Takisita and Tajiri) were less than 100 Bq/kg. The restriction regarding the drinking tap water was cancelled on 1 April except for infants and that for infants was cancelled on 9 May.

Regarding tap water, the government or municipality cannot take an enforced action to restrict its supply and intake. Therefore, it was necessary for individuals to judge the trade-off between the risks of drinking water including low levels of radioactive material and not drinking water. The government should have suggested appropriate information as the basis for making judgment

and carried out proper risk communication.

Moreover, in the case of Iidate village, the instruction to restrict drinking of tap water was continued for a long time (ten days) compared with Tokyo metropolitan and the restriction for infants was kept for more than one and a half months. In addition to the above-mentioned risk communication, this case should be examined from the viewpoint of whether or not a countermeasure of distributing drinking water is necessary (particularly for families including infants) and whether the period untill the cancellation of the restriction instruction regarding the intake of tap water is appropriate. In particular, for the latter viewpoint, after the measurement results of radioactivity concentration firstly decreased to less than 100 Bq/kg on 26 March (sampled on 24 March) in Hanatsuka and Takishita filtration plants and on 30 March (sampled on 29 March) in Tajiri filtration plant, the concentration continuously decreased. Since almost all the measurement results were below the lower detection limit after 11 April (the lower detection limit varied among equipment and measurement conditions, but was approximately 5 - 15 Bq/kg), it is possible that the restriction period should have been shorter considering the other risks of the restricted intake of water.

[Nongovernmental Report] Part 1 Chapter 2 Section 2

The following isssues can be raised in association with tap water monitoring.

Tap water monitoring – communication method with public

- After notification on 23 March 2011 to refrain from providing tap water to infants in the 23 wards of Tokyo and the Tama area, the radioactivity concentration in tap water on 24 March decreased to below the regulation value. For this reason, it was announced that tap water may be used without any concern, including for infants. However, since mineral water could not be obtained in many areas, there were actually severe cases whereby people ultimately had to decide for themselves whether to drink tap water including radioactive materials or to refrain from drinking water and whether or not to continue breast feeding owing to concern of transferring radioactive materials from mother to infant.

- Agricultural and livestock products

Descriptions about Shipping restrictions and monitoring of agricultural and livestock products are given in **[Governmental Interim Report]**, **[Governmental Final Report]**, **[National Diet Report]** and **[Nongovernmental Report]** in the following way.

g Shipping restrictions

The National Basic Disaster Prevention Plan stipulates that the national government shall conduct research on the radioactivity contamination of food and beverages to determine effective and useful measures and, if necessary, instruct relevant organizations to restrict the shipment and/or intake of any contaminated food and beverages.

On March 15, a high concentration of radioactive material was detected in weeds that had been collected (refer to b above). On March 17 of the same year, the NERHQ started a discussion

on measures to be taken for contaminated food and beverages.

On March 19 and 20, radioactive material exceeding the temporary regulation value was detected in: (i) raw milk from Fukushima prefecture; (ii) spinach from Ibaraki, Tochigi and Gunma prefectures; and (iii) leafy vegetables from Gunma prefecture. In response to this, on March 21, head of the Government Emergency Response Center provided the leaders of the Fukushima, Ibaraki, Tochigi, and Gunma prefectural governments with instructions to restrict shipment based on Paragraph 3, Article 20 of the Act on Special Measures Concerning Nuclear Emergency Preparedness, of (i) raw milk from Fukushima prefecture, and (ii) spinach and leafy vegetables from Ibaraki, Tochigi and Gunma prefectures. Additionally, on March 22, it was discovered that a high concentration of radioactive material was detected in some vegetables from Fukushima Prefecture. On March 23, the Government Emergency Response Center provided the head of Fukushima prefectural government with instructions to restrict the shipment and intake of certain vegetables. Subsequently, instructions to restrict shipment were successively issued.

Subsequently, on April 4 of the same year, the NERHQ issued a notice for "Strategies for monitoring planning, shipping restrictions and abolishing shipping restrictions on the basis of products and regions" for the following reasons: many municipalities asked the NERHQ to restrict shipment on a per-region basis rather than on a per-prefecture basis, and the NERHQ determined that it was necessary to establish requirements to abolish shipping restrictions. This notice states that: (i) shipment of a product shall be restricted if it is anticipated that a significant quantity of the product exceeds a temporary regulation value within a wider range of regions and intake of a product shall be restricted if a significantly high concentration of radioactive material is detected in the product; (ii) regions shall be established on a per-prefecture-basis, however, regions shall be established on a per-block basis if the relevant prefectural or municipal office can afford to manage and maintain them; and (iii) shipping restrictions shall be lifted on a per-region basis by dividing a prefecture into more than one region, monitoring shall be performed weekly on a per-region basis in more than one municipality, and if inspection findings register below provisional limit values three consecutive times, then restrictions shall be lifted if an application is made by the relevant municipal office.

From the same day, each of the municipalities planned and performed monitoring of food and beverages according to the policy described above. The NERHQ instructed them to restrict shipment or lift shipping restrictions accordingly.

It was discovered that lower levels of radioactive iodine were detected in food and beverages while radioactive cesium exceeding provisional regulation values was detected in some food products. Based on this finding, on June 27 of the same year, the NERHQ revised their previous policy, which had gone into effect on April 4 of the same year, to include the following new provisions: (i) a product with limited shipping time shall be monitored at least three days before it is due to be shipped; and (ii) restrictions on shipment shall be lifted according to the following conditions: restrictions on shipment based on the detection of radioactive iodine shall be managed as per the conditions described above while restrictions on shipment based on radioactive cesium shall be managed on a per-region basis; and restrictions on shipment shall be lifted if all monitoring results gathered from more than three locations per municipality within the previous month are below provisional regulation values.

On August 4 of the same year, the NERHQ revised their notice of "Monitoring planning, developing shipping restrictions and abolishing shipping restrictions on the basis of products and regions" for the following reasons: radioactive cesium exceeding provisional regulation values was detected in beef, and the time for harvesting rice was approaching (refer to Section h(b) above).

h Other problems concerning shipping restrictions

(a) Farm animals (cattle) feed

On March 19 of the same year, MAFF provided cattle farmers with a "Notice on farming management" (hereinafter referred to as "Notice on Farming Management") via prefectural governments in the Tohoku and Kanto districts to the effect that in order to prevent or reduce

contamination of livestock products with radioactive material, cattle raised in regions where airborne radiation levels higher than normal have been detected shall be fed with hay from grass that has been cut, gathered and stored prior to the date of the nuclear accident in Fukushima Prefecture and stored indoors beyond that date; drinking water for cattle shall be kept in a sealed water tank to prevent falling dust particles from entering; and cattle will not be sent to graze until further notice.

Additionally, on April 14 of the same year, MAFF provided cattle farmers with a notice via prefectural governments in the Tohoku and Kanto districts to the effect that in order to prevent or reduce the contamination of cattle with radioactive material via farm coarse feed (including pasture grass and straw), a provisional permissible value of radioactive material contained in farm coarse feed (including pasture grass and straw) would be established, and that values of radioactive material contained in farm coarse feed that is produced hereafter shall, if used for cattle, be below the prescribed provisional permissible value.

Additionally, on August 1 of that year, prior to the upcoming rice and wheat fall harvest season, MAFF notified all prefectural governments that in order to prevent contamination of cattle with radioactive material via rice bran and wheat bran, a provisional permissible value of radioactive material contained in farm coarse feed as well as in cattle feed including rice bran and wheat bran shall be established. MAFF also notified all prefectural governments that the use, production, or distribution of cattle feed exceeding provisional permissible values shall be avoided.

(b) Measures for beef

On July 8 of the same year, radioactive cesium exceeding the temporary regulation value (500Bq/kg) was detected in beef shipped from Fukushima Prefecture. Subsequently, radioactive cesium exceeding the temporary regulation value was detected in beef shipped from prefectures other than Fukushima Prefecture.

The root of this problem was that the Notice on Farming Management was only addressed to cattle farmers. The Notice was not communicated to grain farmers, who produced rice straw. Furthermore, information and guidance provided to cattle farmers was inadequate and it was discovered that cattle farmers had fed their cattle rice straw that had been stored outdoors and most likely contaminated with radioactive material.

On July 19, the NERHQ instructed the Fukushima prefectural government to restrict the shipment of commercial cattle and subsequently, on August 2, instructed the Miyagi, Iwate, and Tochigi prefectural governments to restrict the shipment of commercial cattle.

On August 4 the NERHQ updated their notice on "Strategies for monitoring planning, developing shipping restrictions and abolishing shipping restrictions, on the basis of products and regions" (established on April 4 of the same year, revised on June 27 of the same year (refer to Section g above)) and agreed to partially lift shipping restrictions based on the premise that all cattle or all cattle farms would be tested.

On and after August 19 of the same year, the local governments that had been instructed to restrict the shipment of beef developed a policy to test and ship commercial cattle, and submitted an application to the NERHQ requesting that shipping restrictions be lifted. In response to their request, the NERHQ lifted shipping restrictions on commercial cattle that had been raised and managed according to the government policy for testing and shipping commercial cattle.

(c) Measures for rice harvested in 2011

On April 8 of the same year, the head of the NERHQ obtained a transfer coefficient (0.1) of radioactive cesium transferred from soil to unpolished rice based on the results of analyses performed by the National Institute for Agro-Environmental Sciences on rice fields and harvested rice. The NERHQ issued a policy to the effect that the upper limit of radioactive cesium shall be 5,000Bq/kg so that the concentration of radioactive cesium contained in unpolished rice would be below the provisional regulation value (500Bq/kg) pursuant to the Food Sanitation Act, and that planting restrictions should be ordered to prohibit the planting of rice seedlings in regions where radioactive cesium contained in freshly harvested rice would most likely exceed the provisional

regulation value.

On April 22, the NERHQ issued a planting restriction order to the head of the Fukushima prefectural government to restrict the planting of rice seedlings within a 20km radius of the Fukushima Dai-ichi NPS as well as in deliberate evacuation zones and emergency evacuation preparation zones.

In August of the same year, MAFF released a plan to conduct a two-stage research process due to the following circumstance: rice is a staple food, a large amount of rice is grown and eaten in Japan and there are various types of distribution systems in Japan. In the first stage, prior to the upcoming rice fall harvest season in 2011, a preliminary survey should be conducted to study the trends in the concentration of radioactive material. In the second stage, a main survey should be conducted to determine whether or not shipping restrictions are required after the rice harvest. In the main survey, the provisional regulation value was not exceeded in any region. However, on and before November 30 of the same year, radioactive cesium exceeding the provisional regulation value was detected in unpolished rice (not tested by direct sampling in the main survey) that was produced in Fukushima-city (formerly Oguni-village) and Date-city (formerly Oguni-village and Tsukidate-village). In response to this situation, the NERHQ instructed the Fukushima prefectural government to restrict the shipment of rice produced in these aforementioned regions in 2011.

[Governmental Interim Report] Chapter V 1 (1)

(c) Measures for rice harvested in 2011

On April 8, the NERHQ set the transfer factor of radioactive cesium transferred from soil to unpolished rice at 0.1 based on the results of analyses performed by the National Institute for Agro-Environmental Sciences on rice fields and harvested rice. The NERHQ issued a policy to the effect that the upper limit of radioactive cesium shall be 5,000Bq/kg so that the concentration of radioactive cesium contained in unpolished rice would be below the provisional regulation value (500Bq/kg) pursuant to the Food Sanitation Act, and that planting restrictions should be ordered to prohibit the planting of rice seedlings in regions where radioactive cesium contained in freshly harvested rice would most likely exceed the provisional regulation value.

On April 22, the NERHQ issued a planting restriction order to the Fukushima prefectural government to restrict the planting of rice seedlings within a 20km radius of the Fukushima Dai-ichi NPS as well as in deliberate evacuation zones and emergency evacuation preparation zones.

In August, the MAFF released a plan to conduct a two-stage research process due to the following circumstance: rice is a staple food, a large amount of rice is grown and eaten in Japan and there are various types of distribution systems in Japan. In the first stage, prior to the upcoming rice fall harvest season in 2011, a preliminary survey should be conducted to study the trends in the concentration of radioactive materials. In the second stage, a main survey should be conducted to determine whether or not shipping restrictions are required after the rice harvest. In the preliminary or the main survey, the provisional regulation value was not exceeded in any region. On November 16, however, radioactive cesium exceeding the provisional regulation value (500Bq/kg) was detected in unpolished rice (from the rice field not covered by direct sampling in either the preliminary survey or the main survey) produced in Fukushima City (formerly Oguni Village).

As rice containing radioactive cesium beyond the provisional regulation value was found after the completion of the main survey, the Fukushima prefectural government from November conducted an emergency survey covering all of the 23,247 rice farmers in (i) former Oguni Village in Fukushima City (the area where rice with radioactive cesium in excess of the provisional regulation value was found for the first time after the completion of the main survey), (ii) areas that include “specific spots recommended for evacuation” and other areas, and (iii) areas where even a tiny amount of radioactive cesium was detected. The emergency survey found rice containing radioactive cesium beyond the provisional regulation value from rice kept by 38 rice farmers. Most of contaminated rice was concentrated in certain areas of Fukushima City and

Date City. Based on the survey results, the head of the NERHQ instructed the Governor of Fukushima Prefecture to restrict the shipment of rice produced in a total of the nine areas, which were formerly registered as cities, towns and villages, in the three cities of Fukushima, Date and Nihonmatsu, by January 4, 2012.

[Governmental Final Report] Chapter IV 5 (1)

a. Establishment of provisional regulation values and shipping restrictions on food

From the middle of the night on March 14, 2011 to dawn of the following day, MHLW and the Ministry of Agriculture, Forestry and Fisheries commenced studies regarding the necessity of regulating radioactive materials in food. On March 15, a debate among the related ministers and ministry employees was also held in NERHQ.

On the same day, March 15, it was revealed that the environmental sample monitoring implemented by Fukushima Prefecture had detected iodine 131 (277,000Bq/kg to 1,230,000Bq/kg) and cesium 137 (31,100Bq/kg to 169,000Bq/kg) in weeds at four locations between 36 km and 46 km from the Fukushima Daiichi Nuclear Plant. In response to this report, on March 16, the Residents Safety Group in the Secretariat of NHRHQ sought advice from NSC's Emergency Technical Advisory Group regarding restrictions on the ingestion of food and drink; in response to this, NSC's Emergency Technical Advisory Group gave advice that the Residents Safety Group should recommend restrictions on the ingestion of home-grown vegetables (excluding root crops, potatoes and vegetables cultivated inside the house) and locally produced milk obtained on or after March 16, 2011 in areas including northern Iwaki City and further north in the Hamadouri region and the Nakadouri region.

On March 17, taking into consideration the advice of the NSC's Emergency Technical Advisory Group and the discussions it held with NERHQ, MHLW established provisional regulation values for radioactive materials under the Food Sanitation Act.

The regulations of the Food Sanitation Act take the basic approach of establishing regulation values, making business operators, including farmers and retailers, primarily responsible for conducting voluntary measurements prior to sale. When radiation readings above the limit are confirmed during tests of food on sale in the marketplace, sales of such items by individual business operators should be prohibited. Prior shipping restrictions are not planned as a general rule.

Voluntary pre-sales measurements by business operators or measurements done of food, after it is distributed do not effectively reduce internal exposure. It is necessary to restrict contaminated food and drink before it is shipped. Measures to restrict the ingestion of food and drink, etc., as stipulated in the Fukushima Prefecture Regional Disaster Prevention Plan that were formulated based on the Emergency Preparedness Guide, basically target the region in the vicinity of the accident. However, in this accident, radioactive materials were emitted over a wide area, so it is necessary to construct a legal framework for imposing food and drink shipping restrictions over a wide area.

NERHQ, rather than Fukushima Prefecture, led the response as stipulated in the Fukushima Prefecture Regional Disaster Prevention Plan; they decided -- based on the Nuclear Emergency Preparedness Act – that in case food contaminated in excess of the provisional regulation values is confirmed in prefectural tests, shipping restrictions should be imposed in the name of the prefectural governor in certain regions, including the region in which food contamination was confirmed.

Fukushima Prefecture, the Tokyo Metropolitan Government, Tochigi Prefecture, Ibaraki Prefecture, and Gunma Prefecture commenced monitoring food from March 16 onwards, and MHLW announced 35 cases exceeding the provisional regulation values by March 20. On March 21, based on the Nuclear Emergency Preparedness Act, Article 20, Paragraph 3, the head of the NERHQ directed the Fukushima Prefecture governor, the Ibaraki Prefecture governor, the Tochigi Prefecture governor and the Gunma Prefecture governor to impose shipping restrictions on spinach and kakina from Fukushima, Ibaraki, Tochigi, and Gunma prefectures, and milk produced in Fukushima Prefecture. By March 22, new contamination in excess of the provisional

regulation levels was reported. On March 23, the head of NERHQ directed the Fukushima Prefecture governor to impose ingestion restrictions and shipping restrictions on head-type leafy vegetables, etc. produced in Fukushima Prefecture in addition to the above restrictions, and also directed the Ibaraki Prefecture governor to impose shipping restrictions on raw milk and parsley produced in Ibaraki Prefecture.

On April 4, NERHQ released its "Approach to the Establishment and Lifting of Items and Zones for Test Plans, Shipping Restrictions, etc." and as a result, although prefectural boundaries are used as a general rule when establishing zones for shipping restrictions, it became possible to use units that divide prefectures, such as into municipalities, etc. Due to this change, the prefectures (which are the organizations that actually perform the tests and impose the shipping restrictions), are able to adopt flexible responses that take into consideration the needs of the residents/ producers. The approach to establishing and lifting items and zones stipulates that it is possible for zones in which a directive to impose shipping restrictions has been issued to lift that directive through an application by the relevant prefecture, on the condition that the food satisfies the provisional regulation values three times consecutively in the weekly tests. Based on this, on April 8, NERHQ lifted the directive to impose shipping restrictions for raw milk produced in a part of the Aizu region in Fukushima Prefecture (Kitakata City, Bandai-machi, etc.), as well as spinach and kakina produced anywhere in Gunma Prefecture.

[National Diet Report] Chapter 4, 4.4.3

Contamination of food and its shipping restriction

On 17 March, the MHLW sent a notification to each municipality not to consume contaminated foods exceeding the regulation value for meals for the time being since radioactive materials were released into the environment from Fukushima Daiichi NPS. This notification was made on the basis of the Food Sanitation Law and the suggestion to use the "Index for restrictions on the intake of food and beverages" made by the Nuclear Safety Commission (NSC) as a temporary regulation value for restrictions of intake and shipping. After that, on 19 March, it was reported that radioactive iodine 131 exceeding the temporary regulation value was detected in raw milk produced in Fukushima prefecture and spinaches produced in Ibaraki prefecture.

The first instruction of the shipping restriction was given on 21 March. The target was raw milk produced in Fukushima prefecture, and spinach and kakina from Fukushima, Ibaraki, Tochigi, and Gunma prefectures. This countermeasure was communicated to each prefectural governor by the Prime Minister, who is also director general of the Nuclear Emergency Response Headquarters on the basis of Paragraph 3, Article 20 of the Act on Special Measures Concerning Nuclear Emergency Preparedness.

On 23 March, the list of shipping restrictions for foods produced in Fukushima and Ibaraki prefectures was expanded (some foods from Fukushima prefecture were also the focus of advice to restrict intake). On 4 April, foods from Chiba prefecture became targets of the shipping restriction; thus, the area and list of foods were gradually expanded with the detection of radioactive contamination in each area.

At first, the target areas of the shipping restriction were set prefecture by prefecture, but after 4 April, shipping restrictions could be set and cancelled on the basis of unit area such as cities, towns and villages partitioning the prefecture. On a basis of an application by the municipal government, the cancellation of the shipping restriction could be permitted under the condition that the radioactivity concentration in foods is observed to be less than the temporary regulation value three times consecutively in the inspection held every week.

On 5 April, the temporary regulation value for radioactive iodine in seafood was notified to all municipalities in Japan to prevent the intake of seafood exceeding the regulation value, because no regulation value had been previously set up in the temporary regulation values and radioactive iodine was detected in seafood the day before.

On 4 April, the principle for the cancellation of the shipping restriction was provided as follows: "Cancellation of the shipping restriction is permitted for an area or food item if the radioactivity concentrations measured in the inspections held every one week are less than the

temporary regulation value three times consecutively", which lead to the cancellation of the shipping restriction of spinach and kakina from the whole of Gunma prefecture and raw milk produced in part of Fukushima prefecture, in accordance with the principle mentioned above.

Even now, foods such as Shiitake mushrooms and rice obtained in the autumn are still under the shipping restriction because radioactive contamination exceeding the regulation value was continuously detected in parts of these regions (as of 12 February, 2012).

(Omission)

2. Example of circulation of beef exceeding the temporary regulation value in the market without being detected in the inspection

This example is about beef circulating in the market exceeding the regulation value without being detected in the inspection by authority. The reason was livestock feed given to cows. This was out of the scope of the inspection, and no alternative measure was considered.

On 8 July, Tokyo Metropolitan government announced that radioactive cesium (cesium 134 and cesium 137) exceeding the temporary regulation value specified in the Food Sanitation Law was detected in edible meat of beef cattle among eleven cows transferred to Shibaura slaughterhouse from the emergency evacuation preparation area in Minamisoma city in Fukushima prefecture (the detection result was 2,300 Bq/kg, the temporary regulation value was 500 Bq/kg). This inspection was carried out upon the request by the MHLW on 6 July. On 8 July, strengthening of the monitoring inspection of beef was requested for Fukushima prefecture and its six neighboring prefectures by the MHLW. The following day, the inspection results for the ten remaining cows were announced and were 1,530 - 3,200 Bq/kg beyond the temporary regulation value.

On 11 July, Fukushima prefecture announced that they would urgently carry out an on-site investigation of all beef cattle farmhouses in deliberate evacuation areas and emergency evacuation preparation areas. Simultaneously, they announced the results of a radiation survey carried out for livestock farmhouses in Minamisoma city on 10 July. The targets of the survey were five kinds of feed (rice straw, oats, grass, feed mixtures and drinking water for livestock). Among them, radioactive cesium was detected in the the rice straw, the oats and the grass. The highest radioactivity concentration was 75,000 Bq/kg (17,045 Bq/kg with correction for moisture content) in the rice straw.

On 14 July, it was clarified that cows provided rice straw containing a high concentration of radioactive cesium were shipped and distributed from beef cattle farmhouses in Asakawa-cho in Fukushima prefecture. The Fukushima prefecture requested that all farmhouses in the prefecture refrain from shipping until urgent on-site investigation was completed on 18 July.

The results of the urgent on-site investigation were released on 18 July. It was clarified that there were 554 cows that were shipped and fed contaminated rice straw between 28 March and 13 July. In response to this, the Japanese government instructed the restriction of beef cattle produced in the Fukushima prefecture, not to be shipped to slaughterhouses or transported outside the prefecture on 19 July. After that, on-site investigations for all beef cattle farmhouses in the prefecture were carried out. In the summary of the investigation results released on 6 August, it was made clear that there were 143 beef cattle farmhouses provided (or that may have been provided) rice straw contaminated by radioactive material, and 867 contaminated cows (slaughtered between 28 March and 15 July) were shipped from 30 of these farmhouses.

The causes of this were that firstly, contaminated rice straw had been provided as feed and secondly, cows fed contaminated rice straw could not be detected by inspection.

At first, the government instructed farmers to use livestock feed that was obtained before the accident or stored indoors, and maintain the supply of radioactive-free feed and water, since livestock feed was under the control of the Ministry of Agriculture, Forestry and Fisheries (MAFF). Moreover, on 14 April, a temporary permissible value for radioactive materials in the original livestock feed was set up and established as a temporary reference not to exceed the temporary regulation value for milk or beef in the Food Sanitation Law. However, it was not preassumed to make feed by gathering grass grown in those days although the government

responded to the accumulation of radioactive material on the storing feed.

The next example is about the inspection system for beef cattle. Cows shipped and transported from deliberate evacuation areas and emergency evacuation preparation areas were divided by the same screening level as that for people using survey meters, that is, decontamination was needed if the survey results exceeded 100,000 cpm (there was no case requiring decontamination among 11,140 cows that underwent screening inspection between 23 April and 11 July, for example, about 85% were lower than 1,000 cpm and the maximum was 16,000 cpm). However, this type of inspection could only survey on the surface contamination and could not detect internally accumulated contamination. Therefore, shipping of contaminated beef or cattle could not be stopped by only screening survey, but beef exceeding the temporary regulation value would not have been distributed in the market if the inspection after slaughter was sufficiently carried out.

[Nongovernmental Report] Part 1 Chapter 2 Section 2

The following isssues can be raised in association with Shipping restrictions and monitoring of agricultural and livestock products.

Shipping restrictions and monitoring of agricultural and livestock products – expansion of contamination due to food chain

- The Notice on Farming Management was not communicated to grain farmers, who produce rice straw. Furthermore, the information and guidance provided to cattle farmers were inadequate and it was discovered that cattle farmers had fed their cattle rice straw that had been stored outdoors and was most likely contaminated with radioactive material. This led to the detection of radioactive cesium exceeding the temporary regulation value in beef.

Shipping restrictions and monitoring of agricultural and livestock products – measurement method for livestock products

- Beef fed by contaminated rice straw could not be identified by inspection after slaughter.

・ Foods

Descriptions about foods monitoring are given in **[Governmental Final Report]** and **[National Diet Report]** in the following way.

ⅰ The status of testing of food products

By the end of February 2012 after the nuclear accident, a total of 117,737 specimens of food products were tested and radioactive materials in excess of the provisional regulation value were detected in 1,162 specimens. The followings can be cited among food products from which the high levels of radioactive materials were detected despite a lapse of some significant period of time after the nuclear accident.

(a) Fruits

A total of 2,396 specimens of fruits were tested by the end of February 2012, and radioactive materials in excess of the provisional regulation value were detected in a total of 28 specimens of eight items – yuzu (citrus junos), Japanese plums, pomegranates, Japanese medlar, figs, chestnuts, kiwi fruits and persimmons (all of them produced in Fukushima Prefecture). Of these fruits, radioactive materials beyond the provisional regulation value were detected in yuzu (citrus junos), pomegranates, chestnuts, kiwi fruits and persimmons even after September 2011. The contamination of these fruits presumably resulted from radioactive materials attached to their trees and leaves immediately after the nuclear accident being translocated to fruits.

(b) Mushrooms

A total of 2,575 specimens of mushrooms were tested by the end of February 2012, and radioactive materials in excess of the provisional regulation value were detected in 165 specimens. Radioactive materials were detected in 122 specimens among them after September 2011, while 80 specimens were picked in municipalities other than Fukushima Prefecture.

It is believed that these mushrooms were contaminated as they absorbed radioactive materials that became attached to places where mushrooms grew, like withered tree logs used for cultivation of shiitake mushrooms. Mushrooms are also believed to have the nature prone to gather cesium.

(c) Seawater fish

A total of 5,051 specimens of saltwater fish were tested by the end of February 2012, and radioactive materials in excess of the provisional regulation value were detected in 162 specimens. Soon after the nuclear accident, radioactive materials in excess of the provisional regulation value were detected in species of surface fish in coastal waters, such as sand eels and whitebaits. However, since radioactive materials beyond the provisional regulation value were detected in whitebaits caught off Fukushima Prefecture on June 6, 2011, no species of surface fish with that much of contamination have been found. Later, radioactive materials in excess of the provisional regulation value have come to be detected in species of bottom fish in coastal waters, and they are still being detected in such fish species as of the end of February 2012. In most cases, contaminated fish has been found in sea areas to the south of the Fukushima Dai-ichi NPS.

These contamination trends are believed to reflect the phenomena that radioactive materials discharged from the Fukushima Dai-ichi NPS into the sea have been carried to the south by the ocean current (the Oyashio current) and that radioactive materials have moved from the sea surface to the bottom of the sea in the course of time.

(d) Freshwater fish

A total of 782 specimens of freshwater fish were tested by the end of February 2012, and radioactive materials in excess of the provisional regulation value were detected in 50 specimens. Radioactive materials beyond that level were detected only in fish living in rivers in Fukushima Prefecture. Since August 2011, in Lake Akagi Onuma in Gunma Prefecture, located some 190km in a straight line from the Fukushima Dai-ichi NPS, fish contaminated by radioactive materials in excess of the provisional regulation value has been found. In the lake in 2012, by the end of February, radioactive materials in excess of the provisional regulation value have been detected in 12 out of 19 specimens, including lake smelt caught on January 6 and Iwana mountain trout caught on January 29.

The contamination of fish in the lake is believed to reflect such things as that freshwater fish has the property that it cannot discharge radioactive cesium accumulated inside the body so easily and that since Lake Akagi Onuma is a caldera lake and the turnover of lake water is slow, radioactive materials tend to remain in the lake.

[Governmental Final Report] Chapter IV 5 (1)

Subsequently, every time contaminated food has been discovered through the tests for radioactive materials performed in each region, NERHQ has added regions and items subject to directives to impose shipping restrictions, or lifted them as appropriate. In the food tests performed during March 2011, a total of 780 specimens in 15 prefectures were tested, and of these radioactivity in 136 specimens exceeded the provisional regulation values. Furthermore, there were a total of 135,571 tests of food, according to announcements made by MHLW, between March 18, 2011 and March 31, 2012, and 1,204 of these tests discovered food with radioactivity exceeding the provisional regulation values.

(Omission)

c Chaos in the testing systems

After the shipping restrictions on food based on the Nuclear Emergency Preparedness Act were stipulated, it was decided that each prefecture would create test plans for food. NERHQ presented the basic approach regarding the items to be tested, the target regions, the frequency of the tests, etc., and asked each prefecture to formulate its own test plans.

The items the NERHQ said should be tested include the following.

(i) Items in which radioactive materials in excess of the provisional regulation values have previously been detected
(ii) Items grown outdoors such as spinach, edible chrysanthemum, kakina, etc. and milk and other items that should be used as indices as designated by the national government
(iii) Major agricultural commodities, taking into account the production situation
(iv) Food distributed in the market
(v) Items separately identified by the national government, taking into account the situation of environmental monitoring and other factors

The headquarters indicated that tests should be performed about once a week as a general rule.

However, the NERHQ and the MHLW left the food tests to the test plans of the prefectures, so the level of the tests varied depending on the prefecture.

The testing equipment and other infrastructure the various prefectures were not adequate at the time of the disaster, and disparities among regions arose. For example, Fukushima Prefecture possessed four germanium semiconductor detectors before the accident, but two of them were in the Okuma Town Environmental Radioactivity Monitoring Center in the evacuation zone, and the remaining two were in the Fukushima Branch of the Environmental Radioactivity Monitoring Center, so none of them could be used for testing food. Fukushima Prefecture had no department in charge of performing tests for contamination of food by radioactive materials in the prefecture's Disaster Provision Main Office, and none of the staff had the know-how necessary to perform such tests. In Fukushima Prefecture from about March 19, the people in charge from the Agriculture and Forestry Office determined the farmers they would visit for the tests, taking into consideration the spatial dose and soil contamination concentration, etc., and began the tests.[238] The Agriculture, Forestry and Fisheries Department of Fukushima Prefecture took the lead in arranging testing, but there was no initial system of testing, so it sent a maximum of 50 samples a day to the Japan Chemical Analysis Center, which performed the tests.

On top of this lack of infrastructure, there were also local governments that were unenthusiastic about performing the tests because of their concerns about the harm to their reputations, so the level of the tests varied depending on the local government. Considering this in light of the intent to develop uniform testing systems for wide areas in order to ensure the safety of the residents, we conclude that there is a problem with these variations among the local governments.

Some private sector companies moved to perform tests voluntarily. Some retail stores even set voluntary standards that were lower than the provisional regulation values and the new standard values, performed tests voluntarily, and did not put food with radioactivity in excess of their voluntary standards on their shelves. In response to these kinds of voluntary tests, on April 20, 2012 the Ministry of Agriculture, Forestry and Fisheries released a document titled "Trustworthy Analyses, etc. for Voluntary Tests of Radioactive Materials in Food" to the heads of food industry

associations, in order to notify them that they should comply with the standard values stipulated by law in their voluntary tests as well, in order to avoid excessive regulations and confusion at the consumption stage. In Japan, which is a free country, there is no reason for state organs to restrict private sector groups that are setting voluntary standards which are stricter than the standards stipulated by law and exercising voluntary restraint, so this response from the Ministry of Agriculture, Forestry and Fisheries is a fundamental problem. However, this notification was released to reflect the interests of the producers and the possible harm to their reputation, which shows the complexity of this problem.

d. Food inspections and the two missing elements

Provisional regulations and actual food inspections failed to account for certain types of nuclear particles and food products. The following paragraphs illustrate the resulting problems.

(i) Initial provisional regulations did not test for iodine in seafood and for strontium in general

The initial provisional regulations did not apply to seafood containing radioactive iodine. This was because consideration was paid mainly to beverages, leafy vegetables, and dairy products, as the original index half-life value is short for radioactive iodine. However, on April 4, 2011, 4,080 Bq per kg, a very high concentration of radioactive iodine, was detected in lancefish off the coast of Ibaraki Prefecture. Upon the advice of NSC, on April 5, MHLW applied the same 2,000-Bq/kg provisional regulation for radioactive iodine in vegetables to seafood.

The provisional regulations also did not set limits on strontium, which is deemed to have a strong effect on the human body. A separate provisional regulation was not provided for strontium, as, during the initial stage of establishing the index values, it was agreed that since strontium mixes with cesium, the ratio of strontium to cesium would be treated as 1:9. For this reason there were very few tests for strontium. The only measurements existing are four samples of sardines, lancefish, and anchovies taken by the Fisheries Research Agency (FRA). This one-time examination did not detect any strontium (detection lower range of 0.02-0.04); however, the lack of strontium testing means concerns by citizens that food was contaminated with strontium endures.

(ii) Inspections and regulations were applied later for fertilizer, feed, and raw mushrooms than for agricultural products

On July 8, 2011, cesium surpassing the provisional limits was detected in beef from Minamisoma City, Fukushima Prefecture, that was processed in Tokyo. The rice straw used as feed for the cows had been contaminated and the screening method being implemented was inadequate. It was discovered that the reason for the high cesium levels was that no one noticed that the beef cattle had been contaminated with radioactive substances. The Ministry of Agriculture, Forestry and Fisheries (MAFF) on March 19, 2011 had issued a notice entitled, "Managing livestock feed in consideration of the nuclear power plant accident," in which it instructed livestock farmers not to give their animals grass or hay that was stored outside after the accident. However, MAFF did not clarify whether the feed restrictions also pertained to rice straw. The Fukushima municipal government's Division of Agriculture, Forestry and Fisheries also issued a document on March 29 entitled, "Great East Japan Earthquake and TEPCO Fukushima Daiichi Nuclear Power Plant accident: Agricultural technology information pertaining to agricultural goods (Issue V)," in which it instructed farmers to cover rice straw stored outside. However, this document did not specify feed already stored outside. It was impossible to detect the contaminated beef beforehand because the government's instructions were inadequate. This resulted in the discovery that there were approximately 4,700 cattle sold nationwide (excluding Okinawa) that had potentially been fed contaminated rice straw.

One lesson learned from the nuclear accident at Chernobyl was that mushrooms are a food product that easily absorbs radioactive substances. Japan from an early stage also detected iodine and cesium that surpassed provisional regulations in raw shiitake and other mushrooms, prompting NERHQ to issue orders to restrict shipping. Shipping restrictions continued to be

applied into the fall to raw brick tuft mushrooms and nameko mushrooms with levels of radioactivity surpassing the provisional limits; however, no measures were implemented for these raw mushroom varieties. It was not until October 6 that MAFF finally set index values for raw mushrooms. This delay was caused by the large amount of time that the Forestry Agency required to actually test for radioactive substance contamination in raw mushrooms.

[National Diet Report] Chapter 4, 4.4.3

The following isssues can be raised in association with foods monitoring.

Food monitoring – regional variations

- Food monitoring was left to the test plans of the prefectures, so the level of the monitoring varied depending on the prefecture. The monitoring equipment and other infrastructure in the various prefectures were insufficient at the early stage after the disaster. Moreover, there were also local governments that were unenthusiastic about performing monitoring because of their concerns about the harm to their reputation, so the level of monitoring varied depending on the local government.

- Forests and subsoils of rivers and lakes

Descriptions about monitoring of forests and subsoils of rivers and lakes are given in **[National Diet Report]** in the following way.

a. Accumulation of radioactive materials in forests

In forests, radioactive materials attached to trees and foliage are transferred to the ground surface when leaves and branches fall, and together with the radioactive materials that have already fallen on the ground through rainfall they penetrate into the topsoil, where they are then absorbed by tree roots and are incorporated into the cycle of the forest ecosystem. Some of these radioactive materials will be dispersed from the forests through soil erosion and outflow. The penetration of radioactive materials into the ground is extremely slow, so the degree of transfer of the materials into the groundwater is also extremely low, resulting in extremely small volumes finding their way into the groundwater. A report stated that in the forests close to the Chernobyl nuclear power plant, the emission of cesium 137 rom the forest remains less than 1 percent annually, and other than natural decay due to the radioactive half-life of the radioactive materials) there has been hardly ny decrease in the radiation concentration. In a study conducted by MEXT in he forests of Fukushima Prefecture, which measured the volume of radioactive cesium transferred due to soil erosion, it was found that the volume of radioactive cesium in the forest that was transferred over a 1.5-month period was a maximum of approximately less than 0.3 percent, indicating that almost no cesium had been transferred. From this, it can be surmised that, as with the case of the forests close to the Chernobyl nuclear power plant, there is a possibility that contamination by radioactive materials near the Fukushima plant could be prolonged.

b. Accumulation of radioactive materials in river and lake beds

It is thought that radioactive materials emitted will accumulate not only in forests, but also in river and lake beds. Radioactive materials that fall to the ground are washed out into rivers and lakes through ground erosion or outflow, and together with silt particles they sink to the beds of

rivers and lakes where they accumulate. This phenomenon was confirmed in the three countries of Ukraine, Russia and Belarus.

In Japan, following the accident, the Ministry of the Environment implemented a water quality monitoring survey of public water expanses in Fukushima Prefecture. According to this survey, measurements at some locations exceeded 10,000 Bq/kg (dry soil) in both river and lake beds. This figure exceeds the standard value of 8,000 Bq/kg, which is set for specified waste requiring special management in terms of collection and transport under Article 20 of the Act on Special Measures Concerning Handling of Radioactive Pollution. Furthermore, continued monitoring has revealed that there are highly contaminated places. (See Table 4.5.1-1.)

[National Diet Report] Chapter 4, 4.5.1

The following isssues can be raised in association with monitoring of forests and subsoils of rivers and lakes.

Monitoring of forests and subsoils of rivers and lakes – lack of understanding of the necessity

- The necessity of monitoring forests and subsoils of rivers and lakes was not sufficiently understood.

(b) Coastal sea area monitoring

- Sea water, subsoils of ocean and sea products

Descriptions about monitoring for sea water, subsoils of ocean and sea products are given in **[Governmental Interim Report]** and **[Nongovernmental Report]** in the following way.

c The monitoring activities that were conducted within the premises of the Fukushima Dai-ichi NPS after the accident

Due to the total loss of AC power supplies resulting from the earthquake and the impact of the ensuing tsunami, on March 11 the eight monitoring posts that had been installed within the premises of the Fukushima Dai-ichi NPS and the fourteen stack monitors that had been connected to each Unit were all unable to be used to monitor. Thus monitoring activities at the Fukushima Dai-ichi NPS began at 17:00 on the same day at more than two locations within the premises of the power station to evaluate changes in the level of radiation dose and estimate the situation of the power plants using the monitoring car6 that belonged to the power station. The monitoring results were successively made available to the public on the websites of TEPCO and NISA.

Afterwards, from March 23, TEPCO installed three temporary monitoring posts within the premises of the Fukushima Dai-ichi NPS to collect data and published their monitoring results from March 27. On March 25 and 29, the existing eight monitoring posts, which had been rendered inoperative, were restored to their former state using a temporary power supply. TEPCO resumed collecting data by making the rounds once a day from April 1. On April 9, the data transmission systems of these existing eight monitoring posts were restored to their former states enabling them to collect and publish data automatically.

At the Fukushima Dai-ichi NPS, TEPCO started collecting and analyzing samples from the

sea near the two water discharge canals on the premises from March 21, when the rubble and debris created by the tsunami were sufficiently cleared away to allow access to the seashore. Because seawater was sprayed into the reactor building, and due to rainfall, water contaminated with radioactivity may have flowed out into the sea. In addition, for the comparison of data, TEPCO also started collecting and analyzing samples from the sea near the two water discharge canals on the premises of the Fukushima Dai-ni NPS.

[Governmental Interim Report] Chapter V 1 (1)

Moreover, from March 21, with the cooperation of the Maritime Safety Agency and the Fisheries Agency, MEXT monitored the sea area beyond a 30km radius of the Fukushima Dai-ichi NPS. The geographical scope of the monitoring area was extended because TEPCO had discharged retained water including low-level radioactive water into the sea on April 4. TEPCO also conducted coastal sea area monitoring in Fukushima Prefecture and Ibaraki Prefecture in the sea area beyond a 30km radius of the Fukushima Dai-ichi NPS.

[Governmental Interim Report] Chapter V 1 (2)

(3) Contamination of seawater, pool water, etc.
a Criteria for bathing areas

On June 7, the Ministry of the Environment began to deliberate on guideline regarding the use of bathing areas in response to the directive from Chief Cabinet Secretary Edano. On June 14, the Ministry held the Roundtable Conference for Radioactive Materials in Bathing Areas to hear from experts on radioactive materials. On June 24, on the basis of advice from the NSC Japan, the Ministry presented a guideline about radioactive materials in bathing areas that indicated: (1) radioactive cesium of 50Bq/liter or less and radioactive iodine of 30Bq/liter or less should be considered as the provisional guideline for the summer of 2011; (2) managers of bathing areas preferably should monitor the concentration of radioactive materials in the water and display the result on a placard or some other means; (3) managers and users of bathing areas preferably should take measures to reduce the effective radiation dose; and (4) managers of bathing areas preferably should monitor the air radiation dose rate at the beach and the like and caution users displaying the result on a placard or some other means when an air radiation dose rate higher than the surrounding area is detected.

[Governmental Interim Report] Chapter V 5 (3)

(e) Discharge into the ocean and release of the result

TEPCO started to discharge the water in the centralized RW/B into the ocean at 19:03 on April 4. The discharge was conducted using ten pumps with a capacity of 25 m3 per hour and completed the discharge at 17:40 on April 10. TEPCO also started to discharge the subdrain water in Units 5 and 6 at 21:00 on April 4, and the discharge was completed at 18:52 on April 9.

TEPCO analyzed radionuclides in the discharged contaminated water in the centralized RW/B and the subdrains of Units 5 and 6 before the discharge and in the seawater before and after the discharge, and published on April 15 the results in the document "Result of Low Concentration Contaminated Water Discharge into the Ocean from the Fukushima Dai-ichi NPS."

That same day, NISA instructed TEPCO to conduct a detailed evaluation on the impact on the environment of the water discharge and the other actions. In response to the instruction, TEPCO compiled the evaluation results of the impact on the environment of the contaminated water discharge from the centralized RW/B and the other facilities into the ocean, the outflow of the highly contaminated water at Unit 2 found on April 2, and the outflow of the highly contaminated water at Unit 3 found on May 11 based on the estimated amount of the discharged radioactive materials and the monitoring results. TEPCO then submitted the outcome of the evaluation to NISA on May 20 as the "Report Concerning the Impact of the Discharged Water whose Radioactive Concentration Exceeded the Discharge Limits into the Ocean."

(Omission)

h. Outflow of highly contaminated water around the water intake of Unit 3

At 10:30 on May 11, while the water injection into Units 1 to 3 continued, TEPCO found water leaking into a pit that was located in the vicinity of the water intake of Unit 3 and contained power supply cables. According to further investigation, the sound of water leakage was detected and it was discovered in CCD camera image at 16:05 (see Attachment V-18 to 20) that water was flowing out from the side of the pit into the screen area.

TEPCO considered that the outflow water came from the T/B in high concentration of radioactive materials similar to the outflow that had been found in the vicinity of the water intake of Unit 2 on April 2, and then started from 17:30 the same day removing the cables within the power supply cable conduit connected to the pit, filling waste cloths in the power supply cable conduit and injecting concrete into the pit. TEPCO finished these tasks at 18:40 (see Attachment V-20) and confirmed at 18:45 the outflow had stopped.

On May 11, with regards to this accident of highly contaminated water outflow in the vicinity of the water intake of Unit 3, NISA instructed TEPCO to check and report on the impact on the ocean and the routes of the inflow and outflow. TEPCO compiled the results of the examination on aspects such as the impact on the ocean and the route of the inflow and outflow, as well as the prevention measures for recurrence and dispersal of the contaminated water in the "Report Concerning the Outflow of Water Containing Radioactive Materials from the Vicinity of the Water Intake of Unit 3 of the Fukushima Dai-ichi NPS" and submitted it to NISA on May 20.

[Governmental Interim Report] Chapter V 6 (1)

Implementation of seawater monitoring

To assess the state of radioactive material emissions, MEXT conducted ocean monitoring. At points approximately 30 kilometers offshore—a distance that allows air radiation levels to be measured while avoiding health risks to human personnel—seawater samples were collected from eight sites approximately 10 kilometers apart. For example, at Site 1, off the coast of the Fukushima Daiichi Nuclear Power Plant, maximum detected levels on March 23 were 76.8 Bq/L for iodine 131 and 24.1 Bq/L for cesium. Air radiation levels at sea, and the radioactivity concentration of ocean dust, were also monitored. In addition, sea-floors were monitored in Miyagi, Fukushima, and Ibaraki prefectures and iodine 131, cesium 134, and cesium 137—all thought to be a result from Fukushima were detected.

Since April 2011, numerical oceanic prediction systems (JCOPE2 and JCOPET) have been used to conduct simulations of the dispersion of radioactivity concentrations on the ocean surface and other quantities

[Nongovernmental Report] Part 1 Chapter 2 Section 1

7. Insufficient seawater monitoring

Seawater monitoring was important in addition to aircraft monitoring in the present accident. Since the Fukushima Daiichi NPS faces the sea, most of the radioactivity released into the air fell into the sea. Moreover, owing to overflow of the coolant water poured using concrete pumps, high-level contaminated radioactive water was discharged through cracks in the concrete, and approximately ten thousand tons of low-level contaminated radioactive water was intentionally discharged into the sea to free up storage space for high-level contaminated water. This led to concern regarding radioactive contamination of the sea, difficulty of fishery operations in the surrounding sea area, and damage caused by harmful rumours or misinformation, that is, whole all Japanese sea products are contaminated by radioactivity.

However, the MEXT in charge of emergency monitoring started seawater monitoring using a ship on 22 March, since there is an insufficient number of permanent monitoring posts unlike land areas. At the beginning, the MEXT requested the Japan Agency for Marine-Earth Science

and Technology (JAMSTEC) to conduct the sampling of seawater and the measurement of the samples. This monitoring was carried out at eight points already used in the "Comprehensive evaluation program of radioactivity in the marine environment" conducted by MEXT and an additional eight points.

However, all these sampling points were only set in a sea area within 30km offshore. These monitoring schemes were unsuitable for issues such as the dispersion of radioactive materials owing to ocean currents and marine sediment.

For this reason, in April, five new monitoring points were added by using five observation buoys for measuring seawater temperature, salinity concentration, tidal current direction and the drift of the current. However, various issues can be pointed out about the way that sea water monitoring ought to be performed. At first, the NISA suggested their view such as “radioactive material will be diffused with a tidal current, and will become diluted when the radioactive material is actually intaken by fishes and seaweed” and did not recognize the need for monitoring in the sea. For that reason, sea water monitoring conducted by the MEXT was limited to the points more than 30km apart from the Fukushima Daiichi NPS. As a result, the dynamics of the radioactive materials released from the source could not be clarified.

Secondly, there was no monitoring system fully considering a regional specific tidal current. As shown in a TV documentary “Seeking hotspots in the sea” broadcast by NHK in November 2011, since sea water off Fukushima Prefecture travels down to the southern region along the coast after the “Oyashio” current meets the “Kuroshio” current, radioactive materials in sea water traveled down to off Ibaraki Prefecture in the southern area of Fukushima Dai-ichi NPS, which led to the situation where radioactive materials temporarily accumulated in sand eels and forced fishermen in Ibaraki Prefecture to refrain from fishing. However, since monitoring points conducted by the MEXT were simply set up in the area 30 km from the site without considering the property of the tidal current, the situation was not sufficiently clarified.

[Nongovernmental Report] Part 2 Chapter 5 Section 3

Descriptions about monitoring for subsoils of ocean are given in **[Nongovernmental Report]** in the following way.

Implementation of seawater monitoring

To assess the state of radioactive material emissions, MEXT conducted ocean monitoring. At points approximately 30 kilometers offshore—a distance that allows air radiation levels to be measured while avoiding health risks to human personnel—seawater samples were collected from eight sites approximately 10 kilometers apart. For example, at Site 1, off the coast of the Fukushima Daiichi Nuclear Power Plant, maximum detected levels on March 23 were 76.8 Bq/L for iodine 131 and 24.1 Bq/L for cesium. Air radiation levels at sea, and the radioactivity concentration of ocean dust, were also monitored. In addition, sea-floors were monitored in Miyagi, Fukushima, and Ibaraki prefectures and iodine 131, cesium 134, and cesium 137—all thought to be a result from Fukushima were detected.

Since April 2011, numerical oceanic prediction systems (JCOPE2 and JCOPET) have been used to conduct simulations of the dispersion of radioactivity concentrations on the ocean surface and other quantities

[Nongovernmental Report] Part 1 Chapter 2 Section 1

Thirdly, there was little understanding of radioactive materials in subsoils of the ocean. The monitoring target set by the MEXT was not subsoils of the ocean but sea water. Consequently, radioactive materials also accumulated in bottom-dwelling coastal fishes (e.g., flat fish and flounder etc.), and accumulation in medium-sized fish due to the food chain started to occur.

Fourthly, responses for the long-term necessity of seawater monitoring have not been sufficient yet. While the accident is not resolved, the possibility of water contaminated with a high concentration of radioactive material seeping out from the underground cannot be denied in

spite of construction to stop the contaminated water flowing out. The monitoring of the high concentration contaminated water should be also continued. There is a necessity for more comprehensive monitoring besides that around the NPS taking into consideration that radioactive materials falling to the ground are released to the sea through a river by rain or decontamination works. At this time, reserchers are mainly conducting the measurement activities in the region except for Fukushima prefecture, but this issue should be addressed by the MEXT that is in charge of monitoring.

[Nongovernmental Report] Part 2 Chapter 5 Section 3

Descriptions about monitoring for sea products are given in **[Governmental Final Report]** and **[Nongovernmental Report]** in the following way.

(c) Seawater fish

A total of 5,051 specimens of saltwater fish were tested by the end of February 2012, and radioactive materials in excess of the provisional regulation value were detected in 162 specimens. Soon after the nuclear accident, radioactive materials in excess of the provisional regulation value were detected in species of surface fish in coastal waters, such as sand eels and whitebaits. However, since radioactive materials beyond the provisional regulation value were detected in whitebaits caught off Fukushima Prefecture on June 6, 2011, no species of surface fish with that much of contamination have been found. Later, radioactive materials in excess of the provisional regulation value have come to be detected in species of bottom fish in coastal waters, and they are still being detected in such fish species as of the end of February 2012. In most cases, contaminated fish has been found in sea areas to the south of the Fukushima Dai-ichi NPS.

These contamination trends are believed to reflect the phenomena that radioactive materials discharged from the Fukushima Dai-ichi NPS into the sea have been carried to the south by the ocean current (the Oyashio current) and that radioactive materials have moved from the sea surface to the bottom of the sea in the course of time.

[Governmental Final Report] Chapter V 5 (1)

Thirdly, there was little understanding of radioactive materials in subsoils of the ocean. The monitoring target set by the MEXT was not subsoils of the ocean but sea water. Consequently, radioactive materials also accumulated in bottom-dwelling coastal fishes (e.g., flat fish and flounder etc.), and accumulation in medium-sized fish due to the food chain started to occur.

Fourthly, responses for the long-term necessity of seawater monitoring have not been sufficient yet. While the accident is not resolved, the possibility of water contaminated with a high concentration of radioactive material seeping out from the underground cannot be denied in spite of construction to stop the contaminated water flowing out. The monitoring of the high concentration contaminated water should be also continued. There is a necessity for more comprehensive monitoring besides that around the NPS taking into consideration that radioactive materials falling to the ground are released to the sea through a river by rain or decontamination works. At this time, reserchers are mainly conducting the measurement activities in the region except for Fukushima prefecture, but this issue should be addressed by the MEXT that is in charge of monitoring.

[Nongovernmental Report] Part 2 Chapter 5 Section 3

The following isssues can be raised in association with monitoring of seawater, subsoils of ocean, and sea products.

Monitoring of seawater, subsoils of ocean, and sea products – lack of understanding of the necessity

- Since the necessity of sea area monitoring was not fully understood, the monitoring area was limited to the region within 30km from Fukushima Dai-ichi NPS at the early stage after the accident. Ocean currents formed around this local area were not considered in the monitoring design, which led to missing knowledge on the dynamics of the transition of radioactive materials from the source.

Monitoring of seawater, subsoils of ocean, and sea products – lack of prediction tools

- Since the seawater off Fukushima Prefecture travels down to the southern region of the Fukushima Dai-ichi NPS along the coast after the "Oyashio" current meets the "Kuroshio" current, radioactive materials in seawater traveled down to off the coast of Ibaraki Prefecture in the area south of the Fukushima Dai-ichi NPS, which led to the situation that radioactive materials temporarily accumulated in sand eels, forcing fishermen in Ibaraki Prefecture to refrain from fishing. In addition, radioactive materials also accumulated in bottom-dwelling coastal fishes (e.g., flat fish, flounder, etc.). The timing of the accumulation of radioactive materials in medium-sized fish owing to the food chain could not be predicted since the monitoring target at the early stage postaccident was not ocean subsoils but seawater.

(2) Prediction of diffusion of radioactive materials

(a) System for Prediction of Environmental Emergency Dose Information (SPEEDI)

To minimize radiation exposure of residents in an emergency and get information on diffusion of radioactive materials, the System for Prediction of Environmental Emergency Dose Information (SPEEDI) has been established. The predictions is to be utilized as a foundamental information to select areas where protection measures such as evacuations are carried out by government or municipality or to choose radiation monitoring points. Descriptions about SPEEDI are given in **[Governmental Interim Report]**, **[Governmental Final Report], [National Diet Report]** and **[Nongovernmental Report]** in the following way.

(1)Overview of the SPEEDI system

The System for Prediction of Environmental Emergency Dose Information (SPEEDI) quickly predicts the atmospheric concentration of radioactive materials and radiation dose in the surrounding area of an emergency situation, including nuclear power stations, based on release sources, meteorological conditions and topographical data. Predicted results are shown with symbols and isolines on a map.

Release sources data for the calculations of the SPEEDI are to be provided by the Emergency

Response Support System (ERSS). The ERSS predicts and analyzes the outcome and subsequent development of the accident based on information concerning the behavior of the reactor, which is provided by nuclear power station operators, and its predicted amounts of discharged radioactive materials are provided to SPEEDI.

The Basic Disaster Prevention Plans stipulates that MEXT should adequately prepare and maintain the SPEEDI system even during normal times and improve necessary functions, including connections to the Off-site center. The Plan also stipulates that MEXT should shift SPEEDI to emergency mode immediately after the Ministry is notified of the occurrence of a specified event (stipulated in Article 10 (1) of the Act on Special Measures Concerning Nuclear Emergency Preparedness (Specific Event)), and make proper predictions on the impacts of radiation and share the results of those predictions with all relevant ministries and agencies.

The Government's NE Response Manual stipulates that if an accident occurs in a commercial reactor, NISA should activate ERSS to grasp release source information, which is transferred to the MEXT. MEXT should predict based on this release source information the impacts of radiation using the SPEEDI computer, which is installed at the Nuclear Safety Technology Center (hereinafter referred to as the "Nuclear Safety Technology Center") and provide the results to the NISA, NSC, all relevant prefectural governments and the Off-site center.

This NE Response Manual stipulates that the results of the SPEEDI calculations should be used at a nuclear incident as the basis of discussions on how to take measures to protect residents in the vicinity of the NPS. Actually, when the national government conducted a comprehensive nuclear emergency response drill in Fukushima Prefecture in 2008, drills on shifting SPEEDI to emergency mode, taking adequate protective actions and verifying the results using SPEEDI were included.

In this Accident the release source information from ERSS on which SPEEDI calculations are based was not obtained. To be more precise, due to the loss of external power supply caused by the earthquake on March 11, TEPCO's Safety Parameter Display System (SPDS), which was installed within the premises of the Fukushima Dai-ichi NPS to provide the reactor data to ERSS, ended up being unable to transfer data to ERSS. Moreover, as described in Section III5(1)b, after 16:43 on March 11, the Government's dedicated line, which sends data from the Fukushima Dai-ichi NPS to the main computer of ERSS through the Off-site Center, became unavailable.

Thus in the implementation of response measures for the nuclear accident, SPEEDI which is based on release source information from ERSS, was not able to perform calculation predictions on the dispersion of radioactive materials since plant data could not be transferred to ERSS as a result of at least two transfer line failures. Against the expectation of aforementioned training drills, it was impossible to utilize the SPEEDI for setting the evacuation zones because SPEEDI could not predict the atmospheric concentration of radioactivity and radiation dose.

[Governmental Interim Report] Chapter V 2

4.3.4 Prediction systems for emergencies

The government developed and deployed ERSS and SPEEDI in order to support the consideration of protective action for residents when a nuclear emergency occurs. Because the progression of events during this accident was so swift and the information from ERSS on sources of release was not available for so long, the calculation results from SPEEDI were not useful to those making decisions on evacuation orders in the earliest stages.

There were some people involved in nuclear emergency preparedness who recognized, before the accident, the limitations of the prediction systems. However, a review of the existing framework in which evacuation orders would rely on the calculation results of the prediction systems was not held. Moreover, no systematic study was done of measures that could compensate for the limitations of SPEEDI or of ways to utilize the calculations' predictions.

1. Outline of the emergency prediction systems

The government had been developing the ERSS and SPEEDI prediction systems in order to

implement nuclear emergency response measures in a swift and appropriate manner. The plan was that, when an accident occurred, ERSS would calculate the amount of radioactive material that was being released from the nuclear facility into the atmosphere by nuclide and time (release source information); based on this release source information, SPEEDI would conduct a predictive calculation of the impact on the environment concomitant with the progression of the accident; and evacuation and other emergency measures would be taken based on the calculation results.

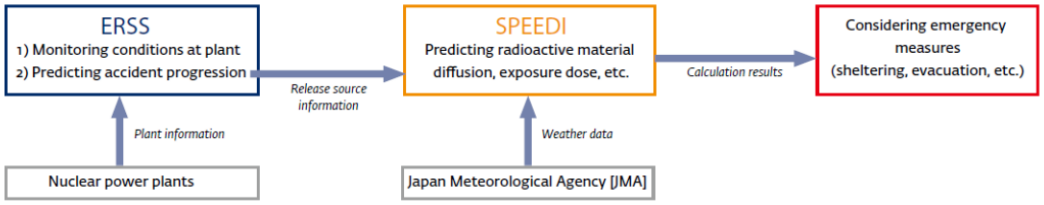

Fig. 4.3.4-1 Outline of the coordination between ERSS and SPEEDI

a. ERSS (emergency response support system)

ERSS is a system that (i) monitors the condition of the reactors at a nuclear power plant and (ii) predicts the progression of an accident and the external release of radioactive material, based on information transmitted from the nuclear power plant.

The Nuclear Power Engineering Test Center (note: this entity conducted a business transfer relating to nuclear safety regulation to JNES on 2003 and dissolved) began developing ERSS in 1987, in the wake of the 1986 accident at the Chernobyl Nuclear Power Plant. ERSS was put into operation in 1996. Its deployment, maintenance, and management, as well as the expansion of its functions, are under the jurisdiction of METI; meanwhile JNES is responsible for the actual operation and management of ERSS, including analyses and predictive calculations.

ERSS works as follows: (i) it automatically collects data from a nuclear power plant on the operation status of electrical power supplies, the coolant condition of the reactors, etc., the pressure and water levels in the reactors, the measured values of radiation, etc., and uses these data to determine the condition of the reactors, reactor containments, etc., using a specific calculation model; (ii) it inputs the results of these determinations into a specific calculation model, and predicts the progression of core meltdown, damage to reactor vessels, loss of containment integrity, etc., as well as making predictive calculations on the release source information.

When plant information is unavailable, it is possible to predict the progression of an accident from typical accident postulates that have already been incorporated in the database and from the analysis data thereof.

The prediction results of the ERSS calculations are sent to NISA-ERC (the Emergency Response Center at METI), NSC, Off-site Centers, etc. to be considered when taking protective action for residents. The ERSS calculation results from release source information are also used for SPEEDI calculations and predictions.

b. SPEEDI (System for Prediction of Environmental Emergency Dose Information)

When an accident occurs that releases radioactive material from a nuclear facility into the outside environment, the SPEEDI system conducts predictive calculations on the radioactive diffusion and the exposure doses of residents, etc. in the surrounding environment, based on release source information and weather forecasts, etc., and displays the results mainly as diagrams on maps.

SPEEDI was developed by the Japan Atomic Energy Research Institute (which merged with Japan Nuclear Cycle Development Institute [JNC] on October 1st, 2005; its current name is Japan Atomic Energy Agency), in the wake of the Three Mile Island accident in 1979 and commenced operation in 1985. At the beginning of its development, SPEEDI was intended to be used to predict such matters as the distribution of radioactive material and exposure doses in the

environment surrounding nuclear facilities, but it later came to be utilized in nuclear emergency preparedness as well. The deployment, maintenance, management, and expansion of SPEEDI functions were placed under MEXT jurisdiction, while the Nuclear Safety Technology Center (NUSTEC) conducts the actual operation, including the use of its calculated predictions.

The function of SPEEDI is to use a specific calculation model to calculate predictions of the airborne concentration, the amount of surface ground deposition and air absorbed dose rates of radioactive material that is released externally, and the exposure dose of residents in the surrounding areas, etc.; this is based on release source information such as (i) the results of predictive calculations with ERSS (ii) unit release rate assumption (1Bq/h) and (iii) other assumed values, as well as topological and other data, weather forecast information, etc. The reach of the calculations is a maximum of a square of 100km on a side (25km at high resolution) and a maximum of approximately 72 hours after release. The results of the calculations are displayed as diagrams on maps and may be viewed at terminals installed at MEXT, NISA-ERC, the NSC, the prefectural office where the site is located, off-site centers, etc.

2. The expected role of the prediction systems before the accident

ERSS and SPEEDI were positioned in the Regulatory Guide: Emergency Preparedness for Nuclear Facilities (NSC RG T-EP-II.01) and Guidelines for Environmental Radiation Monitoring (NSC RG T-EN-II.02) (Monitoring Guideline) as important tools in deciding the evacuation orders and other protective actions for residents. Consideration of protective actions for residents using ERSS and SPEEDI was repeatedly emphasized during disaster prevention drills, according to the Monitoring Guideline. Some people involved in nuclear emergency preparedness had recognized, even prior to the accident, the limitations of the prediction systems. However, a review of the existing framework, in which evacuation orders would be issued relying on the calculations of the prediction systems, was not held before the accident.

a. Position in the Monitoring Guideline

According to the Monitoring Guideline, the actual method of operation for ERSS and SPEEDI is as follows.

(i) During the initial stage after an accident, calculations are made with SPEEDI, inputting some assumed values such as 1Bq/h (which is the so-called “unit release rate assumption”) since it is generally difficult to acquire release source information. The results are used to elaborate the emergency monitoring plan to measure radiation dose rates in the atmosphere, etc.

(ii) In the case where release source information has been obtained from ERSS calculations, this is used to conduct calculations with SPEEDI, to create and distribute diagrams of effective doses from external exposure, etc.; it’s desirable to obtain such diagrams quickly for the considering protective action.

(iii) In the case where the results of emergency monitoring have been obtained, a whole range of diagrams shall be prepared, based on those results and the results of the predictive calculations with SPEEDI, to be used for considering and implementing protective action.

As we have shown, the Monitoring Guideline stipulates that predictive calculations with SPEEDI shall be conducted using unit release rate assumption and other assumed values until release source information is obtained from ERSS, and that once release source information is obtained, such information shall be input into SPEEDI to conduct predictive calculations. However, there is no explicit mention of how to respond in case release information from ERSS is not available for long periods of time.

b. Treatment in the Comprehensive Nuclear Emergency Preparedness drills

During the annual Comprehensive Nuclear Emergency Preparedness drills, exercises had been actually conducted, as per the Monitoring Guideline, to do predictive calculations with SPEEDI (using the release source information derived from ERSScalculated predictions) and decide the scope of evacuation on the basis of the results. No exercises were conducted based on the

possibility that release source information might not be obtained from ERSS for long periods of time.

c. The understanding of the role of the prediction systems on the part of the people involved in nuclear emergency preparedness

Given the positioning of ERSS and SPEEDI in the Monitoring Guideline and their treatment in emergency preparedness drills, bureaucrats gradually came to the understanding that ERSS and SPEEDI were important tools in providing information to assist the decision-making regarding evacuation orders.

Some people engaged in nuclear emergency preparedness at NISA, the NSC, JNES and JAEA began to have doubts about the emergency response drills, and the very idea of relying on the ERSS and SPEEDI calculations when establishing evacuation zones, etc. Some of the main suspicions were:

(i) Whether the ERSS was reliable in predicting the release of radioactive material from the containment vessel in advance, given the difficulty of predicting the timing and magnitude of the damage to the containment vessels with the ERSS analysis code.

(ii) Whether there was a possibility that the accident progression prediction would not function if the progression of an accident at the plant was affected due to some reasons including malfunctions of equipment which does not provide input data to ERSS.

(iii) Whether it was difficult for SPEEDI to predict diffusion of radioactive materials which reflected specific weather conditions such as localized rain, localized snow or other else.

However, as was explained in detail in 4.3.1, there was no progress in holding a review of the Emergency Preparedness Guide to create evacuation orders that did not rely on the calculation results of ERSS and SPEEDI.

[National Diet Report] Chapter 4, 4.3.4

・Utilization and dissemination of information yielded by SPEEDI up to March 15

a. Utilization and dissemination of the results of an hourly basis calculation, assuming a unit radioactivity release rate

As described in Section (1) above, MEXT directed the Nuclear Safety Technology Center, which manages and operates SPEEDI, to switch the SPEEDI system to emergency mode at 16:40 on March 11.

In response to this directive, the Center switched SPEEDI to emergency mode at 16:49 that day. At the same time, the Center started calculations to predict the atmospheric dispersion of radioactive materials on hourly basis using the meteorological data from 16:00 that day and assuming a unit radioactivity release rate of a 1Bq/h from the Fukushima Dai-ichi NPS based on the Environmental Radiation Monitoring Guidelines prepared by NSC. It should be noted, however, that the results of the calculations above was not a prediction based on an actual release rate, but simply a prediction of the direction of dispersion and the relative concentration of radioactive materials in the air based on a unit release rate.

In response to the directive from MEXT, the Nuclear Safety Technology Center provided the predicted results of their unit release rate calculation, to MEXT, the ERC, the NSC, the Off-site Center, the Fukushima Prefectural Office, and JAEA. The Nuclear Center requested that the Nuclear Safety Technology Center adjacent to the Off-site Center provide the results of their unit release rate calculation. In response to the request, at approximately 23:00 on March 11, the Nuclear Safety Technology Center provided the results of their unit release rate calculations only once to the Fukushima prefectural Monitoring Center via email, which had been intermittently available during that time.

Among the organizations that received the unit release rate calculations, the Monitoring Center used the results as a reference to formulate their monitoring program from March 12. Other organizations did not use these results to discuss practical and concrete measures since they thought that the calculations based on an assumed unit release rate did not show any actual

radiation dose levels. They also had no idea of making the results public. As described earlier, the results of the unit release rate calculation, however, had predict the direction of dispersion of radioactive materials and the distribution of relative amounts of radioactive materials, they could have been useful in determining the direction of evacuation of residents (refer to Section 3 (3) c and f).

b. Utilization and dissemination of the results of calculations conducted by organizations based on various assumptions

Besides the unit release rate calculations, between March 11 and 15, MEXT, NISA and NSC conducted calculations to predict the impact of radioactive materials released from the Fukushima Dai-ichi NPS by entering various assumed values into SPEEDI as release source information. Between March 12 and 16, the MEXT, conducted 38 SPEEDI calculations with various release source information and shared the results within the MEXT emergency operation Center (EOC), and provided some of the calculation results to both the ERC and the NSC.

Aside from this, on the night of March 12, NSC made one request for a SPEEDI calculation to the Nuclear Safety Technology Center. The NSC received the calculation results and shared them with its members, members of its technical advisory body at an emergency, and some staff members of the NSC Secretariat. The NSC, however, believed that the calculation results should only be utilized for internal discussion. As a result, the calculation results were not shared with any other organizations.

Meanwhile between March 11 and 15, NISA conducted 45 SPEEDI calculations by entering various assumptions of release source information in order to grasp the dispersion feature of radioactive materials. The obtained predicted results were shared with various functional teams within the MEXT-ERC. The first set of results were provided to the Prime Minister's Office and the Off-site center.

NISA had requested that the Nuclear Safety Technology Center to conduct the SPEEDI calculation to predict the impacts of radioactive materials released from Unit 1 of the Fukushima Dai-ichi NPS and provided the SPEEDI predictions to the Agency staff at just past 1:30 on March 12. The officials gave the predictions to the staff of the Cabinet Secretariat who attempted to share the predictions with the staff of various ministries who were stationed in the basement of the Prime Minister's Office.

NISA sent the Prime Minister's Office the SPEEDI predictions with an accompanying message that NISA believed that the SPEEDI predictions were of low reliability because of calculations based on assumed release source information. Cabinet Secretariat staff, who received the predictions from NISA staff before dawn on the morning of March 12, treated them as reference information and did not report to Prime Minister Naoto Kan (hereinafter referred to as "Prime Minister Kan"). Also NISA itself did not report the predictions to Prime Minister Kan either.

[Governmental Interim Report] Chapter V 2

3. The response by the relevant organizations with regard to the prediction systems when the accident occurred

SPEEDI calculation results were not used to establish the evacuation zones during the initial response to the accident for several reasons: the release source information was unavailable from ERSS for a long period of time; the event progressed rapidly; and it was difficult to predict when the radioactive material would be widely released.

a. The operation status of ERSS

During the accident, the transmission of plant data from the Fukushima Daiichi Nuclear Power Plant stopped because the external power supply was lost and the server installed at the Fukushima Daiichi plant to transmit information on the inside of the reactors, etc. to ERSS had shut down. Moreover, the government's dedicated line for data transmission also broke down. Around the same time, the electric power supply for the reactors' computers was also lost, so ERSS lost the ability to grasp the state of the plants at the Fukushima Daiichi Nuclear Power

Plant.

It was known before the accident that the loss of electric power supplies could become a problem in obtaining release source information for ERSS. Nevertheless, the emergency power supply was left unconnected, and the data did not have multiple transmission routes.

Because of this situation, JNES used ERSS to calculate some predictions on the progression of the accident, etc. based on the analysis results of the plant information (activation and shutdown of equipment, opening and shutting of valves, etc.) obtained from TEPCO by fax and phone, and from analogous events extracted from the database. Part of this was sent to the prime minister's office. Release source information predicted by the results of the analysis of similar events was provided to NISA as well, but this was not based on actual plant parameters and therefore lacked accuracy.

b. The operation status of SPEEDI

Because release source information was not available from ERSS at the time of the accident, prediction calculations, etc. were initially conducted with SPEEDI using release information for unit release rate assumption and release source information predicted on the basis of the results of the analysis of similar events by ERSS.

Under instructions from MEXT, NUSTEC began calculating predictions at 16:40 on March 11 using unit release rate assumptions, and the results were distributed to NISA and other relevant organizations. Figure 4.3.4-2 is the first predictive calculation diagram that was calculated, using unit release rate assumption.

The people in charge at NISA, MEXT, and the Secretariat of the Nuclear Safety Commission also conducted predictive calculations after the accident, in which they used assumed values other than unit release rate assumptions.

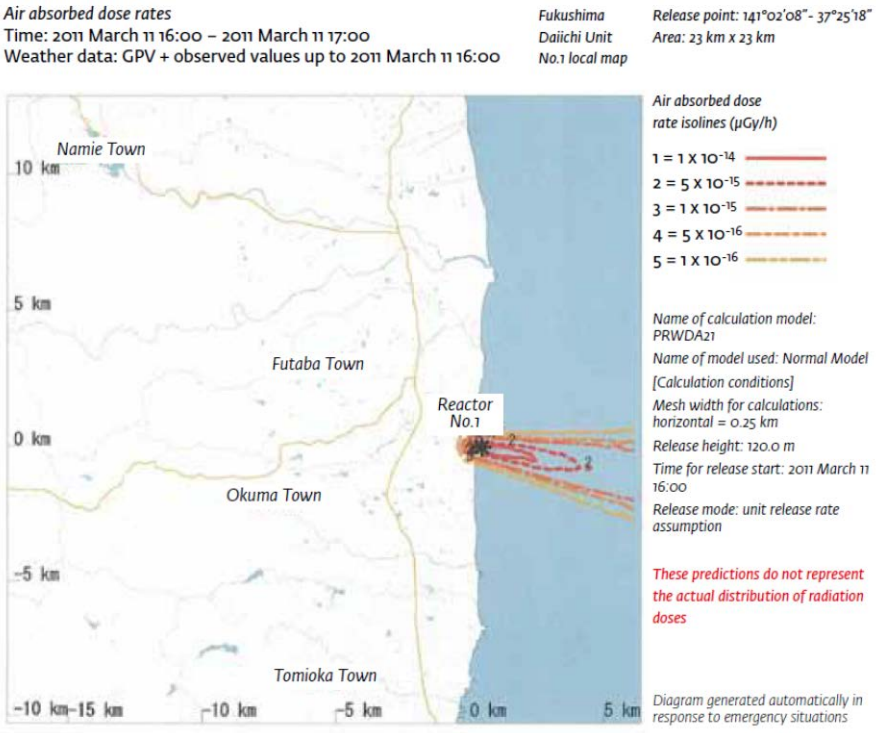

Fig. 4.3.4-2 Diagram of predictive calculations with SPEEDI using unit release rate assumption (predictions for air absorbed dose rates, March 11 16:00-17:00)

[National Diet Report] Chapter 4, 4.3.4

・Utilization and dissemination of information produced by SPEEDI from March 16 onward

b. Performing a retrospective estimation of release source information by SPEEDI and publicizing the predictions

In response to the change of operation body of SPEEDI from MEXT to NSC, as described in Section a above, from March 16, NSC began discussions on how to utilize SPEEDI in a situation where release source information from ERSS was not available.

As part of the discussion, on the following day, March 17, in response to the direction of the Vice Chairman of NSC, Mr. Yutaka Kukita (hereinafter referred to as "NSC Vice Chairman Kukita") and under the cooperation of JAEA and the Japan Chemical Analysis Center, the NSC, led by a member of the Emergency Response Technical Advisory Body, started discussions on how to estimate release source information using SPEEDI and how to estimate the radiation dose based on the estimated release source information.

What is specifically meant by estimating release source information using SPEEDI in a situation where release source information is not available, is to estimate the actual amount of radioactivity released by multiplying the unit amount of radioactivity released by a ratio of observed radiation dose rate at a specific point to a calculated radiation dose rate of the unit release rate at the same point. In the calculation above, the NSC used radiation dose rates in the air obtained by the monitoring and the atmospheric concentration of radioactive materials obtained by dust sampling. To be more precise, the NSC selected data for calculation by analyzing the monitoring data collected before March 15 and newly obtained data from MEXT.

As a result, at around 09:00 on March 23, NSC obtained the results of calculation concerning the cumulative radiation dose in the surrounding areas of the Fukushima Dai-ichi NPS between March 11 and 24. It was found that an equivalent dose of the thyroid gland of infants, which were part of the calculation results, exceeded 100mSv of the criteria for stable iodine distribution (refer to Section 4 (1) c below) indicated in the "the Guideline for Measures for Nuclear Installations" (hereinafter referred to as "Guideline for Measures"), which was prepared by the NSC. Thus NSC Chairman Haruki Madarame (hereinafter referred to as "NSC Chairman Madarame") and NSC member Ms. Shizuyo Kusumi reported these results to the Prime Minister's Office (for the results of this report, refer to Section 3(2)a below).

According to the direction of the Prime Minister's Office, the NSC held a press conference at around 21 p.m. on March 23 and publicize the calculation results.

[Governmental Interim Report] Chapter V 2

c. Reverse estimate calculation of released source term information using SPEEDI conducted by NSC

On March 16, NSC began making reverse estimate calculations of released source term information and simulations of the diffusion of radioactive material based upon those results; it was allowed to directly request the SPEEDI calculation from NUSTEC, although MEXT had the original responsibility for making requests to NUSTEC for SPEEDI calculations.

The reverse estimate calculation of release source information is a method that compares the measured value of the radiation dose rate at a certain geographical point during a certain period of time (obtained from environmental radiation monitoring) and the predicted value for the same geographical point and period of time (derived from SPEEDI predictions using unit release rate assumption), and uses this ratio to retroactively estimate past release source information. It is possible to reproduce the state of diffusion of radioactive material up to that point in time using past release source information derived by this reverse estimate calculation in recalculations with SPEEDI. The results of this numerical simulation are useful for understanding the total picture of the state of environmental pollution and serve as reference material for protective action.

This kind of reverse estimate calculation of release source information was only conducted

during the Chernobyl nuclear accident and the JCO Accident, and no procedure manuals had been prepared. It was difficult for people who had not experienced conducting the calculation during either of those accidents to do these calculations.

In order to conduct reverse estimate calculations, it takes some time after the diffusion of the radioactive material actually begins for a meaningful amount of measured values for comparison purposes to be accumulated from environmental radiation monitoring. Therefore, after the accident's onset, it took some time before it became possible to implement reverse estimate calculations.

The NSC went forward with the reverse estimate calculations and the numerical simulation of the state of diffusion of radioactive material with the help of experts who had past experience with reverse estimate calculations in parallel with the accumulation of measured values from environmental radiation monitoring. It took some time after March 16 to gather the atmospheric concentration data of radioactive nuclides necessary for the reverse estimate calculation, but the reverse estimate was completed on the morning of the 23rd.

[National Diet Report] Chapter 4, 4.3.4

- Relationship between SPEEDI calculation results and evacuation measures

As described in Chapter V 2. (2) a. of the Interim Report, under the MEXT's instructions since the accident occurred on March 11, the Nuclear Safety Technology Center, which manages and operates SPEEDI, calculated the likely atmospheric dispersion of radioactive materials on hourly basis assuming a unit radioactivity release rate of a 1Bq/h from the Fukushima Dai-ichi NPS and reported the results of the calculations to relevant organizations.

The calculation results were useful in making judgment on which direction people should be evacuated as they predict the directions of dispersion of radioactive materials. But none of these organizations used these results to discuss practical evacuation measures nor considered making them public, since the organizations thought that the calculations based on an assumed unit release rate did not show any actual radiation dose levels.

[Governmental Final Report] Chapter IV 2

c. SPEEDI utilization policy

(a) Problems with the systems and the entities that make use of them

SPEEDI is a system that can predict radiation dose rates in the surrounding environment when a nuclear accident occurs, based on the emissions source information that is transmitted from the Emergency Response Support System (ERSS). However, the ERSS may fail to function in collecting and transmitting the reactor information when a nuclear accident occurs, and in such a situation SPEEDI itself, too, might fail to function. Therefore, the policies of utilizing SPEEDI when the ERSS cannot function should have been reviewed beforehand, and the results of the review should have been shared among the personnel concerned to respond to the accident.

Nevertheless, many of the individuals who were responsible for taking response measures in the event of an accident had a belief that there would be no room to allow for the utilization of SPEEDI in evacuation activities once the ERSS failed to function. The Guideline for Environmental Radiation Monitoring (NSCRG T-EN-II.01) has a clause on the methods of utilizing SPEEDI in the event that emissions source information cannot be obtained (i.e., when the ERSS does not function). However, no consensus had been reached on whether this could be applied to evacuation activities. Furthermore, no clarification had been made as to the entities that would make use of SPEEDI (operation and public announcement) in the event that an off-site center failed to function.

(b) SPEEDI and evacuation orders

One of the major reasons as to why SPEEDI was not effectively utilized, as described in (a) above, is considered to lie in the fact that any of the relevant organizations did not have an idea of

its potential role in the implementation of evacuation activities, being in preconception about the impossibility of utilizing SPEEDI in evacuation activities when emissions source information could not be obtained from the ERSS. However, prediction was possible through SPEEDI by assuming the unit emissions, even when the emission sources information could not be obtained, and actually the prediction results had been obtained; it may be concluded that, if the prediction results by assuming the unit emissions had been distributed, there was room of allowance for the respective local governments and residents to be able to select a more appropriate timing or direction to evacuate.

The relationship between the actually released evacuation orders (those for the Fukushima Dai-ichi NPS were released since March 12) and the SPEEDI information (predictions assuming unit release) is discussed earlier in Chapter IV. 2. (3) above. Table VI-1 below sorts out the relationship between the specific orders and SPEEDI data, and possible specific evacuation procedures etc. (timing of evacuation, direction of evacuation, etc.) provided the SPEEDI information had been used.

For a simple practical discussion, the third order from among the three evacuation orders since March 12 is examined here: the case of stay-indoor order within 20-30 km from the accident site at 11:00 a.m. on March 15. In this case, a little before the order (at 08:30 a.m. to 10:15), a high radiation dose rate of around 10,000 μSv/h had been measured, at a point near the main gate of the Fukushima Dai-ichi NPS, and late at night on the same day (23:15 to 23:55), about 7,000 to 8,000 μSv/h high level dose rate had been still recorded (see Fig. IV-6 in Chapter IV. 2. (3) d. above), indicating a larger amount of release of radioactive materials than before.

Specifically, SPEEDI predicted dispersion mostly towards the land (to south-west to north-west) from March 15 to March 16. Therefore, even if implementing evacuation, it appears that it was possible to minimize the out-door exposure to radiation by keeping the initial order to stay indoors first for the meantime and waiting the time periods, while staying alert to SPEEDI information, when the SPEEDI's prediction of dispersion constantly avoids overlapping with the evacuation route (for example, after 07:00 on March 16, when the prediction of dispersion was coast bound and did not overlap with whichever evacuation route was taken). Actually, as reviewed in detail earlier in Chapter IV 2 (3) d, there is a possibility that the evacuees from the Minamisoma City and Namie Town who had begun evacuation on March 15, particularly in the evening or later (after around 15:00), might have taken their evacuation route overlapping with the predicted direction of dispersion of radioactive materials. A detailed release of advice on the evacuation route and timing based on the SPEEDI information could have avoided these situations to happen.

As seen above, even in cases that the information of the source of emissions was not available from ERSS, there seems to have been room for effective use of SPEEDI.

Table VI-1

Evacuation Orders	The predictions by SPEEDI and possible evacuation policy based on it
05:44 on March 12 ・ Evacuation from 10km zone from the accident site	○ Constantly coast bound (towards southeast) from 05:00 am to noon ○ Southbound from 13:00 to 15:00 ○ Westbound from 15:00 to 16:00, northwest to north from 16:00 to 18:00
	[Possible evacuation policies] The predicted dispersion was constantly coast bound in the morning after the evacuation order. Even if radioactive materials were being released, evacuation was possible well in order. As dispersion was predicted south bound into the afternoon, the residents from the south of power station had to be careful in evacuation.
18:25 on March 12 ・ Evacuation from 20km	○North bound from 18:00 to 19:00 ○Almost constantly coast bound (towards northeast) from 20:00 to 10:00 on the next day, March 13.
	[Possible evacuation policies]

zone from the accident site	The predicted dispersion was true north bound from the time of evacuation order until 20:00. Later on until about noon on the next day, March 13, predicted dispersion was mostly coast bound. Therefore, even if radioactive materials were being released, evacuation well in order was possible later in the evening.
11:00 on March 15 ・Stay-indoors in the 20 to 30km zone from the accident site	○South west bound from 11:00 to noon ○North west bound from 13:00 to 02;00 on the next day, March 16 ○South to south east bound after 03:00 on the next day, March 16
	[Possible evacuation policies] Many residents actually evacuated despite the stay-indoor order. The predicted dispersion after the order, however, was constantly land bound: west to north west bound after the order and only changed to west to south bound over the night until early morning of the next day, March16. Incidentally, a large amount of radioactive materials were released from March 15 to March 16. The dispersion was being predicted to change to coast bound for the first time after 06:00 on March 16. Therefore, there appears to be a possibility of limiting exposure risks to radiation, by an advice on the evacuation timing based on this prediction.

[Governmental Final Report] Chapter VI 1

ERSS and SPEEDI are systems to forecast future events based on a certain calculation model. In particular, if release source information cannot be retrieved from ERSS, SPEEDI data alone lacks the accuracy to serve as a basis for establishing evacuation zones. In this accident, events unfolded very rapidly and the results of the projection could not be utilized for the initial evacuation orders. Although some nuclear emergency preparedness practitioners were aware of the limitations of the projection systems, no reviews of the framework for issuing evacuation orders based on the calculations of the projection systems hade been completed prior to the accident. Nor was the network of environmental radiation monitoring improved to offset the limitations of the projection systems.

After the accident, release source information could not be retrieved from ERSS for many hours. Related organizations, including NISA and MEXT, concluded that SPEEDI's calculated results could not be utilized, and so the system's results did not contribute to the initial evacuation orders. The results of the calculations from reverse estimate culclations that were disclosed by NSC at a later date were misunderstood, and believed to have been projections from the time the accident occurred. This gave rise to further misunderstanding and the belief that the government could have prevented residents' exposure to radiation had the results been disclosed promptly and SPEEDI been effectively utilized in making decisions about the initial evacuation orders.

[National Diet Report] Chapter 4, 4.3

d. Treatment of the predictive calculation results from SPEEDI by the government and Fukushima Prefecture

As we saw in 3, a., a situation such as this accident, in which release source information could not be obtained from ERSS for some time after the accident, and only predictive calculations with SPEEDI using unit release rate assumptions and assumed values were possible, was not anticipated by the Monitoring Guideline and was not postulated by the relevant organizations, including NISA and MEXT.

The senior officials and the officials in charge at these relevant organizations decided that "the accident is not a situation where SPEEDI can be used" and reached the essential conclusion that SPEEDI would not be utilized. As a result, methods of using SPEEDI calculations were not systematically considered during the initial response, not only between these relevant organizations but also within the organizations themselves. The predictive calculations were partly

used merely as reference material for deciding the measuring points of the emergency monitoring and determining orders of priority for screening. During the initial response to the acident, the results of SPEEDI calculations were not transmitted to the politicians at the Prime Minister's office who were in effect considering protective action for the residents.

The SPEEDI results had been sent by email to the Fukushima Prefecture Headquarters for Disaster Control from March 12 on, but there was little will to systematically utilize the results, and 65 of the 86 emails received were deleted without sharing the information within the organization.

(Omisssion)

c. The possibility of utilizing the SPEEDI calculation results

Even in cases, such as in this accident, where SPEEDI cannot be utilized to establish evacuation zones for the initial response, there are situations where it can be actively used in considering protective action for residents, beginning with the reverse estimate calculations that the NSC conducted on this occasion.

As the Monitoring Guideline stipulates, for example, when establishing an emergency monitoring plan it can be utilized as reference information when determining the directions and places for reinforcing surveillance, even if there are uncertainties.

Also, in cases such as venting, where the timing for releasing radioactive material is determined by the people in charge, it may be possible to obtain information for considering protective action for residents by conducting predictive calculations with SPEEDI—even if the calculations are based on assumed values–by assuming that a release will occur at the time of the venting.

We believe that there was a possibility to utilize SPEEDI as a tool for betterinformed decision-making regarding life-saving and other related activities at and near the accident site, as an alternative to evacuation. In this accident, the evacuation areas were established as concentric circles for the entire range of the people within the area, without exceptions, which meant that the firemen and other people conducting rescue operations for the victims of the earthquake and the tsunami had to regretfully suspend activities. In order to continue, to the extent possible, life-saving and other activities whose suspension would cause extremely large losses, we believe that it would be useful to predict areas where the impact of the diffusion of radioactive material is expected to be relatively small, and then to transmit that information in a timely manner to the places where the activities are taking place by combining the information with monitoring information.

(Omission)

5. The announcement of the SPEEDI calculation results, which led to misunderstanding and confusion

On March 23, NSC announced the results of its numerical simulation of the diffusion of radioactive material based on reverse estimate calculations. Because the information made public was misinterpreted, and was believed to be the results of prior predictions, residents mistakenly believed they would have been able to avoid radiation exposure if the SPEEDI calculation results had been made public at an earlier time, and that the results could have been used for decisions made regarding evacuation and sheltering.

a. The sequence of events for the announcement of the SPEEDI calculations results

As explained in 3, d., at the time of the accident, MEXT, NISA and the other relevant organizations concluded that SPEEDI essentially could not be utilized. Moreover, the results of the SPEEDI calculations consisted of information that was to be utilized by the persons in charge in the relevant organizations, and were not assumed to be of direct use by residents. This is why, at the beginning, the SPEEDI calculation results were not made public and demands from the media for their disclosure were not met.

Later, on March 23, under instructions from Chief Cabinet Secretary Edano, NSC announced

the results of the numerical simulation of the diffusion of radioactive material based on their reverse estimate calculation.

From April 26 on, also under orders from Edano, each of the relevant ministries and agencies disclosed SPEEDI results. However, the disclosures of the results were conducted separately by NSC, NISA and MEXT, and some confusion resulted, such as in the case where Special Advisor to the Prime Minister Goshi Hosono announced in a press conference that all the calculation results had been made public, only to find that some ministry and/or agency had failed to disclose them.

Table 4.3.4-1 shows the sequence of events for the announcement of the SPEEDI results.

The government did not sufficiently explain the functions, etc. of these calculation results from SPEEDI before their announcement, resulting in misunderstanding and confusion among the residents, who naturally wondered whether SPEEDI could have been utilized effectively in determining evacuation orders during the initial response to the accident.

Table 4.3.4-1 Sequence of events of the announcement of SPEEDI calculation results

Date	Substance
March 15	Media requests during MEXT press conference that SPEEDI calculation results be made public.
March 23	NSC announces calculated values from reverse estimate calculations for release source information. ((a) below: calculated values for radiation doses from internal exposure of thyroid in children.)
April 10	NSC announces calculated values from reverse estimate calculations for release source information. ((a) below: calculated values for radiation doses from external exposure of thyroid in children.)
April 25	Chief Cabinet Secretary Edano orders disclosure of all SPEEDI calculation results.
April 26-	Disclosure by MEXT, NSC ((b) below: calculations in (b) below are currently disclosed together on the MEXT website.)
April 30	Special Advisor to the Prime Minister Hosono (Executive Director, Integrated Headquarters) announces in press conference that all SPEEDI calculation results have been disclosed.
May 2	Hosono announces in press conference that there were some undisclosed SPEEDI calculation results.
May 3-	Announcement by MEXT, NISA ((c) below).
(a) Results of reverse estimate calculations of release source information based on values from emergency monitoring, etc. (b) Results of predictive calculations based on unit release rate assumption at the stage where release source information from ERSS is not known. (c) Results of predictive calculations using postulated amount released in case where release source information from ERSS is not available.	

b. Insufficient explanation by the government at the time of the announcement of the results of reverse estimate calculations

The results of the numerical simulations of the diffusion status of radioactive material based on reverse estimate calculations that NSC announced on March 23:

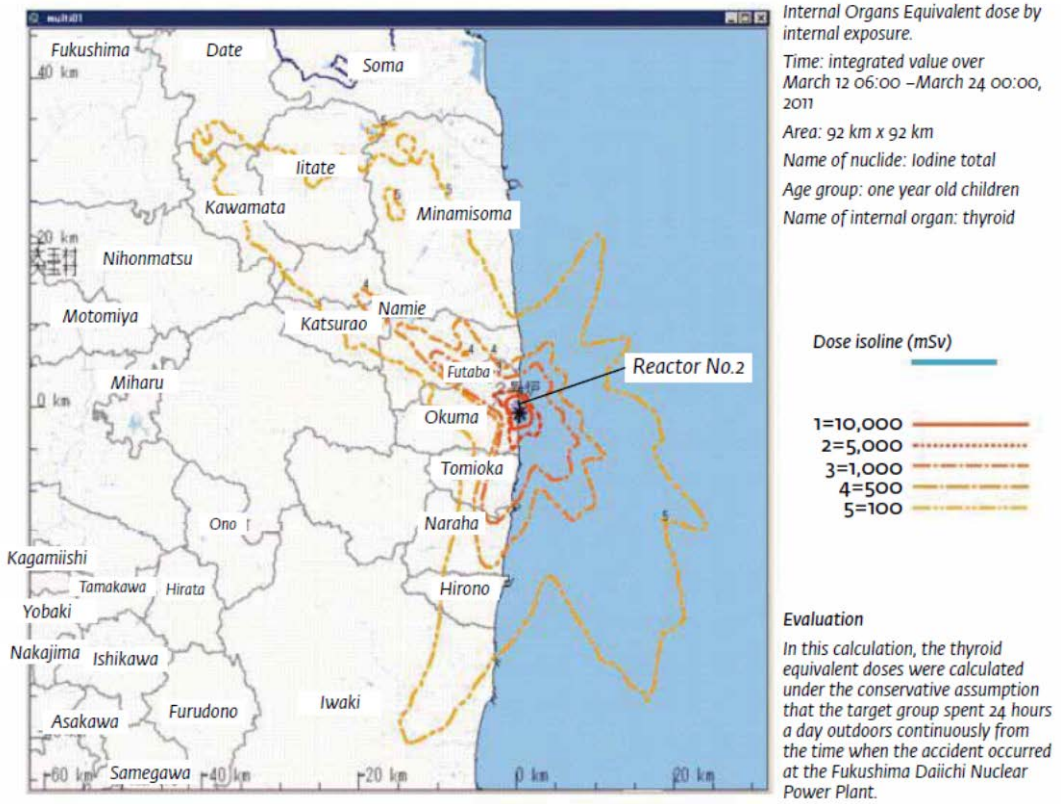

Fig. 4.3.4-6 Results of the reverse estimate calculations of release source information using SPEEDI made public by NSC on March 23
(Calculation results of radiation dose from internal exposure of thyroids in children)

The results of the numerical simulations of the diffusion status of radioactive material based on reverse estimate calculations that NSC announced on March 23:

The calculation results that NSC announced on March 23 were a numerical simulation of the past diffusion of radioactive material based on the reverse estimation of release source information from the measured values of radioactive nuclide concentration from the emergency monitoring. Since the results of the numerical simulation were calculated to ensure that they coincided with the actual measured results of the emergency monitoring, it was a foregone conclusion that there would be no contradiction between the numerical simulation calculated as the state of past diffusion of radioactive material and the actual results of the emergency monitoring.

In making the March 23 announcement, the government did not sufficiently explain the nature of the numerical simulation or the difference between it and ordinary SPEEDI prediction results; instead, it merely announced the data as calculation results using SPEEDI. Because of this, the misunderstanding spread among residents that the government had obtained the results of accurate predictive calculations and then hidden them, and that radioactive exposure could have been avoided.

c. How the SPEEDI calculation results should be handled

When information subject to a degree of uncertainty, such as the SPEEDI calculation results, is made public without distinguishing it from accurate information, it may result in unnecessary anxiety among residents and create confusion. It is necessary to explain such information in a detailed and careful manner, so that the residents have an accurate understanding of its substance and significance.

The explanations by the government in its answers in the Diet, press conferences, etc. so far

have not been consistent. For example, highly contradictory statements have been made repeatedly by government officials, with some stating that the scope of SPEEDI utilization was narrow in the first place and others explaining that better responses would have been possible had SPEEDI been utilized in this accident.

The response of the government with regard to the announcement of the SPEEDI results was problematic. (In 3.6 we take up in detail how government information disclosure should be conducted during emergencies.)

[National Diet Report] Chapter 4, 4.3.4

There is an argument in the discussion on the use of the SPEEDI, that is, what level of accuracy is necessary for scientific endorsement of the evidence or what level of "uncertainty" can be allowed. Of course, prediction is usually accompanied by a certain level of uncertainty, but in the Fukushima nuclear accident, the uncertainty was increased because the accuracy of the source information used in the prediction of the release of radioactive materials was unknown. It must be difficult in reality to use prediction data calculated with increased uncertainty of the source material used to make a judgement.

However, information and tools could not be obtained as their availablity was limited in the Fukushima nuclear accident. Therefore, efforts should have been made to maximumly utilize them with more consciousness of safety, in other words, to reduce the possibility of receiving radiation exposure as much as possible even if a constant "uncertainty" was remaining. Since the NISA and MEXT ought to have considered that the leaders in the Prime Minister's office were strongly aware of wind direction, wind speed and perspective of wind direction, utilization of the prediction data of the SPEEDI would have been possible for use as one of the materials for judgement if the data was informed to the leader of the Prime Minister's office.

[Nongovernmental Report] Part 2 Chapter 5 Section 3

The following isssues can be raised in association with the System for Prediction of Environmental Emergency Dose Information (SPEEDI).

System for Prediction of Environmental Emergency Dose Information (SPEEDI) – underutilization of prediction results

- Since the external power supply was lost following the earthquake and the Government's dedicated line for sending data became unavailable, the release of source information from the Emergency Response Support System (ERSS) on which SPEEDI calculations are based was not carried out. For this reason, the Nuclear Safety Technology Center provided the predicted results of their unit release rate calculation based on "the Environmental Radiation Monitoring Guidelines", to the Ministry of Education, Culture, Sports, Science and Technology (MEXT), the Emergency Response Center (ERC), the Nuclear Safety Commission (NSC), the Off-site Center, the Fukushima Prefectural Office, and the Japan Atomic Energy Agency (JAEA) in response to the directive from MEXT on 11 March 2011. However, these predicted results were neither utilized to discuss practical evacuation measures nor disclosed to the public, since the calculations based on an assumed unit release rate did not show any actual radiation dose levels.

- On the night of 12 March, NSC made one request for a SPEEDI calculation to the Nuclear Safety Technology Center. The NSC received the calculation results and shared them with its members, members of its technical advisory body in an emergency, and some staff members of the NSC Secretariat. The NSC, however, believed that the calculation results should only be utilized for internal discussion. As a result, the calculation results were not shared with any other organizations.

- Meanwhile between 11 and 15 March, the Nuclear and Industrial Safety Agency (NISA) conducted SPEEDI calculations by entering various assumptions of release source information in order to grasp the dispersion trend of radioactive materials. The obtained predicted results were shared with various functional teams within the MEXT-ERC. A few results were provided to the Prime Minister's Office and the Off-site Center. However, NISA sent the Prime Minister's Office the SPEEDI predictions with an accompanying message that NISA believed the SPEEDI predictions to be of low reliability because the calculations were based on assumed release source information. Cabinet Secretariat staff treated them as reference information and did not report them to the Prime Minister.

(b) Simulation system on the diffusion of radioactive materials in the ocean

Descriptions about the simulation system in the ocean are only given in **[Nongovernmental Report]** in the following way.

> Since April 2011, numerical oceanic prediction systems (JCOPE2 and JCOPET) have been used to conduct simulations of the dispersion of radioactivity concentrations on the ocean surface and other quantities.
>
> **[Nongovernmental Report] Part 1 Chapter 2 Section 1**

The following isssue can be raised in association with the simulation system in the ocean.

Simulation system on the diffusion of radioactive materials in the ocean – lack of prediction tools in the emergency preparedness system

- No simulation system for the diffusion of radioactive materials in the ocean has been established in the nuclear emergency preparedness system, since people do not live on sea area, unlike on land.

(3) Evacuation of residents

Overview of evacuation instruction are given in **[Nongovernmental Report]** in the following way.

Sequence of evacuation instructions

The Tokyo Electric Power Company sent an Article 15 Notification to notify the occurrence of an emergency situation in the Fukushima Daiichi NPS based on the Act on Special Measures Concerning Nuclear Emergency Preparedness. Two hours and 15 minutes after receiving this notification, the government declared a nuclear emergency situation at 19:03. After that, evacuation instructions issued by the government can be divided into three steps. The first step is the series of evacuation instructions issued at the early stage after the accident. At 20:50 on 11 March, the Fukushima prefecture government issued the first evacuation instruction for residents living within a 2km radius of the Fukushima Daiichi NPS. About 30 minutes later, at 21:23, the government issued an evacuation instruction for residents within a 3km radius and a stay-indoors instruction for residents within 3-10km of the Fukushima Daiichi NPS. Moreover, at 5:44 on 12 March, the government issued an evacuation instruction for residents living within a 10km radius considering the increase in pressure of Unit 1. In addition, at 18:25 on the same day, the government expanded evacuation zone to the area within a 20km radius considering the hydrogen explosion at Unit 1. This sequence indicates that four different evacuation instructions were issued within 24 hours after the first evacuation instruction. The second step is the two instructions issued in the middle of March. Four days after the occurrence of the earthquake, at 11:01 on 15 March, the government issued a stay-indoors instruction for residents within a 20-30km radius. Ten days later, on 25 March, the government requested the residents of the same area to voluntarily evacuate. The third step is the revision of the evacuation instructions issued in middle and late April. On 11 April, one month after the occurrence of the accident, Chief Cabinet Secretary Mr. Edano referred to two items, the establishments of a deliberate evacuation area and emergency evacuation prepared area as a revision of the evacuation zone. Ten days after that, on 21 April, the establishment of restricted area with a penalty for entering the area within a 20km radius and the reduction of the evacuation area for the Fukushima Daini NPS from 10km to 8km were announced. Moreover, the next day, 22 April, Mr. Edano annoounced three items, the cancellation of the stay-indoors instruction for the residents within 20-30km, and the establishments of a deliberate evacuation area and an emergency evacuation prepared area.

Table 1 Sequence of evacuation instructions

3/11	14:46	地震発生	
	15:42	東電	第10条通報(全交流電源喪失)
	16:45	東電	第15条通報(非常用炉心冷却装置注水不能)
	18:33	東電	(福島第二)第10条通報
	19:03	政府	原子力緊急事態宣言
	20:50	福島県	2km圏避難指示
	21:23	政府	3km圏避難指示
			3~10km圏屋内退避
3/12	5:44	政府	10km圏避難指示
	7:45	政府	(福島第二)原子力緊急事態宣言
			3km圏避難指示
			3~10km圏屋内退避
	17:39	政府	(福島第二)10km圏避難指示
	18:25	政府	20km圏避難指示
3/15	11:01	政府	20~30km圏屋内退避
3/25		政府	20-30km圏内に自主避難要請
4/11		官房長官、避難指示の見直しに言及	
4/21		20km圏内警戒区域の設定 (福島第二)10kmから8kmに避難範囲縮小	
4/22		20~30km圏屋内退避区域の解除(いわき市外れる) 計画的避難区域の設定 緊急時避難準備区域の設定	

[Nongovernmental Report] Part 2 Chapter 5 Section 4

Descriptions about criteria and zones, communication, and implementation and cancelation of measures of evacuation and stay in house are given in **[Governmental Interim Report]**, **[Governmental Final Report], [National Diet Report]** and **[Nongovernmental Report]** in the following way.

(a) Criteria and zones of evacuation and stay in house

a. Implementation of evacuation programs regarding the Fukushima Dai-ichi NPS accident

In response to the fact that all AC power supplies were lost and the Emergency Core Cooling System was unable to provide water to Fukushima Dai-ichi NPS, Prime Minister Kan declared a nuclear emergency situation at 19:03 on March 11 and established the Nuclear Emergency Response Headquarters (NERHQ) in the Prime Minister's Office (refer to Section III 2 (1)).

In response to the declaration of the nuclear emergency state at the Fukushima Dai-ichi NPS, the Prefectural Nuclear Emergency Response Center discussed an instruction of evacuation for citizens within a 2km radius of the nuclear power plant, where regular nuclear emergency drills and exercises were conducted. At 20:50 that day, Prefectural Governor Yuhei Sato instructed citizens an evacuation within a 2km radius of the Fukushima Dai-ichi NPS.

This evacuation instruction was not issued on the basis of a specific act but de facto measure to prevent a disastrous scenario. In response to this order, officials from the towns of Okuma and Futaba took all possible measures by alerting citizens in the area, using a municipal disaster management radio communication network, sound trucks and having fire fighters make door-to-door visits.

Later, after a press conference by Chief Cabinet Secretary Edano concerning the declaration of the nuclear emergency state, NSC Chairman Madarame, Vice Chairman of the Nuclear and Industrial Safety Agency, Eiji Hiraoka (hereinafter referred to as "Vice Director-General of NISA Hiraoka"), and TEPCO executives convened on the fifth floor of the Prime Minister's Office (not

at the Crisis Control Center on the basement floor), where concerned ministers asked for their opinions on the conditions of the nuclear reactors, the range of the evacuation area and other matters.

In that discussion, various opinions were offered including "reactor cores might be damaged in the worst case scenario" and "a vent operation is required to avoid that." In terms of the range of the evacuation area, the Nuclear Emergency Guideline, which was created by the NSC, states that the range of the emergency preparedness zone (EPZ) where emergency countermeasures are sufficiently taken should be within a 10km radius but the preventive action zone (PAZ) that is described in a document of the International Atomic Energy Agency (IAEA) is the area within a 3km radius. So "within a 3km radius" is sufficient, even if it assumed that a vent operation is required. In addition, Vice Director-General of NISA Hiraoka explained that a regular evacuation drill is conducted within a 3km radius under a supposed vent operation. Based on these opinions and explanations, the evacuation was instructed for the zone within a 3km radius, and a stay-indoors was instructed for the zone within a 3 to 10km radius from the Fukushima Dai-ichi NPS.

In response to this decision reached in a meeting held on the fifth floor of the Prime Minister's Office at 21:23 that day, the NERHQ instructed the Fukushima Prefectural Governor and all relevant local governments to issue an evacuation order to citizens within a 3km radius of the Fukushima Dai-ichi NPS and to issue a stay-indoors order to citizens within a 10km radius of the power station. At 21:52 the same day, Chief Cabinet Secretary Edano held a press conference concerning the evacuation orders.

Subsequently, no vent operation was conducted despite an abnormal increase in the pressure inside the primary containment vessel at Unit 1 and despite the fact that the implementation of a vent operation at Units 1 and 2 was instructed by the Prime Minister. Before dawn on the morning of March 12, concerned ministers discussed the range of the evacuation zone again on the fifth floor of the Prime Minister's Office in the presence of Vice Director-General of NISA Hiraoka and NSC Chairman Madarame. During this discussion, an opinion was expressed that it would not be necessary to extend the evacuation zone if a vent operation were conducted under well-controlled conditions but, if taking a conservative stance on this matter, even a relatively significant hazard could be handled if an EPZ were expanded to within a 10km radius. Based on this opinion, it was decided that the evacuation zone would be expanded to within a 10km radius. At 05:44 on March 12, the NERHQ instructed the Fukushima Prefectural Governor and all relevant local governments to issue an evacuation order to citizens within a 10km radius of the Fukushima Dai-ichi NPS. At 09:35 the same day, Chief Cabinet Secretary Edano held a press conference about the evacuation order. A 06:15 the same day, after the decision was made to expansion the evacuation zone, Prime Minister Kan flew to Fukushima Dai-ichi NPS by helicopter.

During a vent operation had still been tried at 15:36 on March 12, there was an explosion in the Reactor Building of Unit 1. A discussion was held on the fifth floor of the Prime Minister's Office about how to grasp the plant situation and how to take protective measures. It was decided that an evacuation order would be issued to citizens within a 20km radius. At 18:25 on March 12, the NERHQ instructed the Fukushima Prefectural Governor and relevant local governments to issue an evacuation order to citizens within a 20km radius of the Fukushima Dai-ichi NPS.

At 20:32 the same day, Prime Minister Kan addressed the Japanese people to explain the expansion of the evacuation zone range. Following Prime Minister Kan, at 20:50 the same day, Chief Cabinet Secretary Edano talked about the explosion at the Reactor Building of Unit 1, explaining that it was not the explosion of the primary containment vessel so a large volume of radioactive material would not leak out. He also explained the expansion of the evacuation zone range.

Subsequently, the following incidents occurred in succession: at 11:01 on March 14, Unit 3 exploded; at around 06:00 on March 15, a big boom was heard from Unit 4; at around 08:11 the same day, some damage to the fifth floor of the Reactor Building of Unit 4 was confirmed; and at 09:38 on the same day, a fire broke out in the northwest section of the third floor of the Reactor Building of Unit 4. In response to these incidents, at 11:00 on the same day, the NERHQ issued an order to the Fukushima Prefectural Governor and all relevant local governments to issue a

stay-indoors order to citizens within a 20 to 30km radius of the Fukushima Dai-ichi NPS. Immediately after this, a press conference by the Prime Minister and the Chief Cabinet Secretary was held to explain the order in greater detail.

(Omission)

(2) Decision, instruction, communication and implementation of long-term evacuation programs

a. How high-level radiation points were found outside the evacuation zone and how the Government handled them

From March 16, the NSC evaluated the radiation monitoring data that was collected by MEXT (refer to Section 1(2)a) above. As a result, high radiation doses (values greater than 10mSv of the stay-indoors evacuation criteria prescribed in the Nuclear Emergency Guideline) were located at points outside the 30km radius. On March 18, the NSC asked NISA to investigate the presence of private houses around these points. The NSC then asked MEXT to install fixed cumulative radiation dose meters at these points to conduct environmental monitoring.

However, on March 20, the NSC judged that high radiation doses had occurred at this time of year due to the influence of both radioactive clouds (plumes) that passed from midnight to the early morning of March 15 and the rainfall that deposited radioactive materials on the ground surface and that because radiation doses would decrease due to both physical decay of radioactive materials and rainfall, it was not necessary to immediately change the stay-indoors evacuation zone in this situation.

In the meantime, the NSC, as described in Section 2 (3) b above, performed the SPEEDI retrospective estimation of the release source information. On March 23, the NSC performed a SPEEDI infant thyroid gland equivalent dose calculation based on a limited number of monitoring results. As a result, the NSC estimated that there were areas with high equivalent doses beyond the designated evacuation zone to the northwest and south of the Fukushima Dai-ichi NPS. The NSC took this fact serious and reported the following to the Prime Minister's Office: (i) the SPEEDI retrospective estimation of release source information, which was conducted for an outdoor stay for 24 hours, should be considered to be overestimation of the radiation dose, (ii) the estimation, which was based only on data obtained from two locations in Fukushima prefecture and one location (Tokai-mura) in Ibaraki prefecture, were lacking in accuracy, and (iii) it might require a great deal of time to make prior arrangements to facilitate the implementation of evacuation programs. Based on this report, it was decided that the evacuation zone should not be expanded immediately and that further discussion should be devoted to this issue by conducting research on the exposure of infant thyroid glands to radiation to confirm the data values based on actual measurement. In addition, the retrospective estimation results were publicized on the same day.

In response to the results of the SPEEDI retrospective estimation, on March 24, Cabinet Secretariat advisor, Mr. Toshiso Kosako (hereinafter referred to as "Advisor Kosako"), provided an advisory report of “Advice for Evacuation Zone and Intake of Iodine Tablets” to the Prime Minister's Office stating that it would not be immediately necessary to implement the intake of iodine tablets and that, as a temporary countermeasure against the current situation, it might be preferable to begin a voluntary evacuation of residents in stay-indoors evacuation zones within a 20 to 30km radius. The NSC received an order from the Prime Minister's Office to summarize what the NSC would suggest doing based on the advice of Advisor Kosako. On March 25, the NSC provided NERHQ with "Advice for emergency monitoring and protective countermeasures," stating that, at this time, it might not be necessary to change the current evacuation and stay-indoors evacuation zones; it might be necessary to strongly advise residents in areas where radiation doses were likely to be relatively high to begin voluntary evacuation, even if they were in a stay-indoors evacuation zone within a 20 to 30km radius; and it might be better, from a protective point of view, to advise residents in areas where radiation doses were not very high to begin voluntary evacuation.

In addition, on March 29, in response to a request for further consideration from the Prime Minister's Office, the NSC submitted its summary report of recommendations on high radiation

dose locations (Namie-town, Iitate-village) beyond a 30km radius of the Fukushima Dai-ichi NPS to the Prime Minister's Office stating that, concerning areas of high radiation doses, cumulative radiation doses might be approximately 28mSv if a person regularly spent time outdoors from March 15 to March 28; cumulative radiation doses might be approximately 21mSv, even taking into consideration the shield effect of wooden houses; and the cumulative radiation doses were already considered to be beyond the 10mSv of the stay-indoors evacuation dose level and that residents in these areas should stay indoors for as long as possible.

Subsequently, in response to instructions from the Prime Minister's Office, NISA instructed officials from Namie-town and Iitate-village to tell residents to stay-indoors for as long as possible in order to avoid radiation exposure, even if they lived outside the 30km radius.

(Omission)

c. Halt of daily services

From March 15, when the stay-indoors evacuation order was issued, more and more residents began to stay indoors. Supermarkets, banks and other stores, which were necessary for daily life, were rapidly disappearing. Under these conditions, it was hard not only for residents who lived within the stay-indoors evacuation zones, but also for those who lived outside the zones to live their lives.

For example, in Iwaki-city, from March 15, a stay-indoors evacuation order was issued to residents in one area in the north of the city. However, since misinformation had spread that the stay-indoors evacuation order had been issued to the whole city, convenience stores and supermarkets, whose employees had been evacuated, successively closed down. In addition, there were fewer and fewer trucks available in the city. Under these circumstances, for example, a firefighter with a heavy-vehicle license had to go to Koriyama-city to drive a tank truck filled with basic necessities back to Iwaki-city.

In Minami-soma-city, residents who lived within the stay-indoors evacuation zone voluntarily evacuated and stores in the city began to close down. In addition, fewer and fewer trucks were available within a 30km radius of the stay-indoors evacuation zone. Such a situation caused the distribution of essential items to be interrupted making it hard for residents to live their daily lives. Thus, between March 18 and 20, and on March 25, chartered buses were made available to evacuate groups of residents.

In response to this situation, on March 25, Chief Cabinet Secretary Edano held a press conference stating that the distribution of essential items had been interrupted making it hard for residents to maintain their daily social lives and that, depending on how things developed, there was no denying that the levels of radiation could increase and another evacuation order might be issued. He concluded by instructing residents in the evacuation zone to stay indoors.

In addition, at the Local NERHQ on the same day, Chief Cabinet Secretary Edano instructed Local NERHQ that there be adequate communication with cities, towns and villages located within the stay-indoors evacuation zone and that, depending on their needs, proper countermeasures should be taken either by providing residents with support for their daily lives or by helping them with their evacuation. In response to the instructions, it was decided that the head of the Local Headquarters should visit cities, towns and villages in the stay-indoors evacuation zone. On March 25, he visited the mayors of Minami-soma-city and Namie-town. Subsequently, he visited the heads of the each city, town and village located in the stay-indoors evacuation zone and explained the evacuation plans and exchanged opinions with them.

In addition, between March 26 and 27, NERHQ first-hand observations both in Minami-soma-city and Soma-city allowed the Local NERHQ to conduct a comprehensive study of the halt of daily commodities. On March 26, the Local NERHQ dispatched staff to Minami-soma-city to be stationed as government liaison officers.

[Governmental Final Report] Chapter V 3

d. Relationship between a stay-indoors order in a 20-30km radius (at 11:00 on March 15) and

SPEEDI

At 11:00 on March 15, the government issued a stay-indoors order to residents within a 20-30km radius of the Fukushima Dai-ichi NPS. According to the SPEEDI calculation results assuming unit release rates since 11:00 that day (see Figure IV-5), radioactive materials emitted from the Fukushima Dai-ichi NPS were predicted to disperse to the southwest from 11:00 to 12:00 of the same day, but from the west to the northwest from 13:00 March 15 to 2:00 March 16. From 3:00 March 16 onward, they were predicted to disperse from the south to the southeast.

At 9:00 on March 15, prior to the stay-indoors order above, the high radiation dose rate of 11,930μSv/h was measured near the main gate of the Fukushima Dai-ichi NPS (see Figure IV-6). According the SPEEDI calculation results assumed unit release rates around the time when this dose rate was measured, radioactive materials emitted from the Fukushima Dai-ichi NPS were predicted to disperse to the southwest from 9:00 to 10:00 the same day. At around 23:00 on March 15, the high radiation dose rates of about 7,000μSv/h to 8,000μSv/h were measured again near the main gate of the Fukushima Dai-ichi NPS. According to the SPEEDI calculation results assuming unit release rates since 23:00 the same day (see Figure IV-5), radioactive materials emitted from the Fukushima Dai-ichi NPS were predicted to disperse to the northwest from 23:00 March 15 to 2:00 March 16.

While the government issued the stay-indoors order on March 15, Minami Soma City provided guidance to evacuate out of the city to those who wanted to move out on the same day onward, and many residents evacuated to Iitate Village and Kawamata Town. In the morning of March 15, Namie Town, at the mayor's judgment, already decided to evacuate residents to Nihonmatsu City, and implemented the evacuation after communicating the decision to residents (for the evacuation situation in Minami Soma City and Namie Town, see Chapter V 3. (3) f. and c. of the Interim Report, respectively). Of residents of these municipalities, those who began evacuating early in the evening of March 15 (around 15:00) were likely to have followed the evacuation routes in the same direction as the dispersion of radioactive materials.

[Governmental Final Report] Chapter IV 2

Evacuation within a 3km radius and stay-indoors instruction within a 3-10km radius

Evacuation within a 3km radius and stay-indoors instruction within a 3-10km radius were issued from the Prime Minister's office at 21:23 on 11 March as an "instruction for making assurance" although radioactive materials had not leaked at that time. In this section, three items, whether or not the timing of the evacuation instructions was appropriate, whether the distance of 3km radius was appropriate and the procedure for the decision of the evacuation instructions, are discussed below.

As for the first item the timing of the evacuation instruction, the lateness can be highlighted as a problem. At first, it took two hours and fifteen minutes from the sending (at 16:45) of the Article 15 Notification of the occurrence (at 16:36) of an emergency situation in the Fukushima Daiichi NPS to the declaration (at 19:03) of an emergency situation issued by Prime Minister's office. This lateness was due to about a one hour delay in obtaining the approval of Banri Kaieda, the Minister of Economy, Trade and Industry (METI) (at 17:35), and an additional delay of a little less than one hour because of a report that need the approval of Prime Minister Naoto Kan, and he had to quit attending a meeting once (at 18:12) between majority and minority party heads.

Moreover, the Prime Minister's office announced the following message simultaneously with the emergency situation declaration (at 19:03) and did not immediately issue the evacuation instruction.

"As of now, no effects of radioactive materials on the outside of the facility have been confirmed. Therefore, for residents and visitors, there is no need to immediately take any special actions at this time. Please stand by in your home or present place without starting to evacuate in a hurry and get the latest information through disaster prevention radio communications set by local government, television and radio and so on. Again, there is currently no leakage of radioactivity outside the facility. Please remain calm."

The timing of the evacuation instruction for residents living within a 3km radius was two hours

after (at 21:23) this declaration and thirty minutes after this evacuation instruction for residents within 2km was announced to Ookuma and Futaba cities by Fukushima prefecture.

This evacuation instruction was not retroactive and not announced after radioactive materials had leaked outside the facility. It can be highly evaluated that the instruction was previously issued as a precautional measure assuming a possible situation. However, generally, it is difficult to judge the situation on the basis of information released just after an accident. The evacuation instruction for residents around the nuclear power plant in the present accident should also have been issued as early as possible.

The International Atomic Energy Agency (IAEA) recommended the establishment of a precautionary action zone (PAZ) where evacuation should be carried out before or shortly after a major release owing to an accident at the nuclear facility. However, no PAZ was established, in spite of the fact that the leader of the nuclear safety measures division in Fukushima prefecture and some citizens requested the Nuclear Safety Commission to adopt this concept during the period of the revision of the Emergency Preparedness Guideline in 2007 in Japan. If this PAZ was established in the guideline before the major release in the accident, it may have been possibe to announce an evacuation instruction just after the accident at an earlier timing.

It took less than 5 hours from the report of the occurrence of an abnormal event from TEPCO to the announcement of the evacuation instruction. It can be highlighted that there was a possibility that residents might be exposed to radiation when the event rapidly progressed and evacuation of the residents whose risk is the highest was delayed and carried out in the evening when the evacuation zone was expanded.

Considering the above-mentioned findings, it cannot be overlooked that two hours and fifteen minutes was needed from the Article 15 Notification to the declaration of an emergency situation, and the evacuation instruction was not announced at the time of the declaration of an emergency situation because radioactivity was not yet released and finally the evacuation instruction was delayed until two hours later. When the safety of the residents is the first priority, it is necessary to make a system enabling the immediate announcement of an evacuation instruction just after the Article 15 Notification and enableing rapid evacuation after the actual instruction.

There are many serious issues in the validity of the region of the second item “3km radius”. The region of the 3km radius was determined taking into consideration that 1) it was sufficient to make an area within a 3km radius evacuation zone even if venting of the reactor is assumed to be necessary to avoid the worst case scenario, 2) the PAZ concept in the emergency preparedness guideline and IAEA was firstly considered and 3) a 3km radius was set for the vent of the reactor in the exercise of the evacuation. In addition, this was determined through an agreement with Haruki Madarame, Chair of the Nuclear Safety Commission, in accordance with the manual of the nuclear disaster measures. The region within a 3km radius which was determined as a precautional measure on the basis of advice from the experts, is regared as valid.

As for the third item, procedure for decision of the evacuation instructions, it can be pointed out that confusion occurred qwing to the shutdown of the operation of the Off-site Center. Originally, the decision to implement the evacuation instruction was to be carried out in the Off-site Center set near the nuclear power plant. However, measures such as evacuation instructions were examined separately at the fifth floor and crisis control center in the basement first floor because the Off-site Center failed and information communication was imcomplete.

It must be a problem to spend much time to announce the evacuation instruction around Fukushima Daiichi NPS. In the future, it is necessary to clarify the decision body for evacuation instruction and the way the Off-site Center ought to be run. Moreover, it is also important to solve the communication problem in the crisis at the Prime Minister’s office since it is necessary to clarify the accurate information for the purpose of the safe evacuation of residents.

Evacuation instruction for residents within a 10km radius

The decision to change the stay-indoors instruction within a 3-10km radius to an evacuation was announced at 5:44 on 12 March taking into consideration the risk of hydrogen explosion owing to the increase in pressure in Unit 1. In parallel with the instruction to evacuate within a 10km radius, venting of the reactor in Unit 1 was prepared and carried out. However, the Prime

Minister's office did not issue the instruction of the evacuation within a 10km radius considering that venting was underway.

The determination of the distance of a 10km radius was relatively easy because it was assumed in the the emergency preparedness guideline and was within the range (8-10km radius) of the emergency preparedness zone (EPZ) where emergency countermeasures should be sufficiently taken. The timing of the instruction was also adequate from the viewpoint of the protection of residents because it was announced considering that the evacuation area was not expanded in preparation for something that had already occurred, but for the possibility of the occurrence of something. On the other hand, the instructions to evacuate or stay indoors outside a 10km radius after this should be verified.

Evacuation instruction for residents within a 20km radius

The instruction to evacuate within a 20km radius was decided at 18:25 on 12 March taking into consideration the hydrogen explosion (explosion of reactor building) that occurred at 15:36 on the same day, the possibility that a similar explosion may occur in Units 2 and 3, and the insufficiency of the 10km radius if recriticality happens. The points for verification are the following two questions; why was the distance set at 20km and why was it set concentrically?

The issue of the distance of 20km in the first point is the obscure evidence, unlike for the distance of 10km assumed in the emergency preparedness guideline. There is conflicting information in the evidence for the 20km radius. According to the news, a member of staff in the MEXT involved in the decision to instruct evacuation within a 20km radius on 12 March said that there was no evidence used in determining the 20km radius, the number was intuitively decided. However, Special Advisor to the Prime Minister, Mr. Goshi Hosono contradicted, that at least there was no MEXT staff involved in the decision table. This sounds to me outrageous because it may be said by guessing that someone has a part in leaking information. After this serious situation suddenly happned, I asked where the region was where the health of the public would be damaged. As a result, the answer of an area with a radius 20km was provided by experts. I do not think the judgment was inappropriate.

Next, can we say that the evacuation region within a 20km radius was sufficient? According to Deputy Chief Cabinet Secretary, Mr. Tetsuro Fukuyama, there was a possibility that both the residents and the staffs supporting the evacuation would be exposed to radiation if a new explosion occured during the three days that were predicted for the completion of the evacuation within a 20km radius. Moreover, there was no preassumption of the location for the evacuation in the case of the evacuation area beyond the 10km radius as it was not assumed in the emergency preparedness guideline. As the United States instructed their citizens, if the evacuation area within an 80km radius is decided, a radius of 50km or 80km would not be practical and the evacuation would become extremely difficult, because Fukushima city (about 300,000 people) and Nihonmatsu city (about 60,000 people) would be in the evacuation area in addition to Futaba town (about 70,000 people) overlapping with the 20km-radius area.

In other words, if the evacuation area is thoughtlessly expanded, traffic jams would occur in the routes for evacuation, which would lead to the possibility that residents around the nuclear power plants who have a higher risk could not rapidly evacuate. In addition, it would become difficult to support the residents who could not evacuate by themselves, such as the elderly and inpatients. Moreover, taking into consideration the limited places that can accept the evacuated residents, the distance of a 20km radius could have been adequate. However, it should be noted that there were some problems in specifying the area within the 20km radius because there was no map to cover the area in the Off-site Center and evacuation within a 20km radius was beyond the assumption in the emergency preparedness guideline.

The second point that the evacuation area was set concentrically to avoid the issurance of a series of different instructions for evacuation that may lead to patchwork-like evacuation areas, may not be a mistake considering the possibility of rapid changes in wind direction. For example, it is assumed in the evacuation drill in nuclear power plants to basically set the emergency preparedness zone concentrically. In some cases, a fan-shaped evacuation zone that is formed as a part of a circle is set considring the wind speed and direction. In the reports by the IAEA or the

NRC, the evacuation instruction is basically set by dividing the area concentrically, although there are different points set among the nuclear power plants.

However, four different evacuation instructions were announced within 24 hours after the occurrence of the accident if counting the evacuation instruction within a 2km radius announced by Fukushima prefecture. It should also be noted that there were many reasons why people who live in safe area finally evacuated or some of the residents were severely burdened such as many transfers to different shelter sites due to anxiety and confusion arising from numerous conflicting evacuation instructions.

In addition, the role of the municipality during an emergency situation has been clarified because a series of evacuation instructions were made by a top leader in the Prime Minister's office. Originally, the evacuation instructions were made at the Off-site Center where the municipality staff work. However, in this accident, Okuma city was the only city that sent staff to the Off-site Center among six cities or towns. Other municipalities could not send their staff owing to their involvement in responding to the earthquake and tsunami, and implementation of the evacuation of residents within a 3km radius. This accident indicates an overwhelming lack of ability of the municipality to respond to a complex disaster including a nuclear accident. These could be significant points for discussion on the role of the municipality in an emergency including the implementation of the evacuation.

Stay-indoors instruction for residents in a 20-30km radius

After the series of events that occurred after the evacuation instruction for residents in a 20km radius on 12 March (hydrogen explosion in the reactor building in Unit 3 on 14 March, hydrogen explosion in the reactor building in Unit 4 on 15 March and the related fires), the Prime Minister's office instructed the residents in a 20-30km radius to stay indoors on 15 March. The decision of this instruction to stay indoors was made following advice from Mr. Haruki Madarame, Chair of the Nuclear Safety Commission (NSC), that is, there is no need for evacuation beyond a 20km radius. However, the problem is just extending the time to stay indoors.

Originally, the stay-indoors instruction was carried out for the reason that radiation exposure during staying indoors while the radioactive plume is passing is lower than that during evacuating outdoors. For this reason, some countries have set a number of days for the stay-indoors instruction. However, there was no regulation in Japan, which accordingly led to a forced stay-indoors instruction for a long time. The stay-indoors instruction area of 20-30km radius caused in a difficult situation for those living there, because commodities necessary for life could not be gained and fundamental medical services such as hospitals could not be utilized.

The negative influence from the extension of the stay-indoors instruction affected the area beyond 30km radius. As an example, we can use Iwaki city located in a 30-50km radius from the nuclear power plant. Although there were few areas within the 30km radius in Iwaki city, the mayor of Iwaki city requested all of its citizens to refrain from doing outdoor activities. As a result, many citizens who lived outside of the 30km radius (50,000 people out of 340,000 people) evacuated out of the city. Moreover, the number of people who thought they should also evacuate increased upon seeing many people evacuating from the area within a 20km radius through Iwaki city. The outflow of residents gave a strong impression of dangerous, which made delivery workers afraid of radiation exposure. This resulted in a shortage of commodities in the area beyond the 30km radius. Such a vicious circle produced difficulties in the economical activities and lives of the residents in the region of a 20-30km radius and the surrounding area.

Evacuation instruction not announced

On 12 March, Chief Cabinet Secretary Mr. Edano said in a press conference "It was not as if the explosion such as a large volume of radioactive material would lead to the leaking…. The present countermeasure does not indicate the occurrence of a specific danger for the residents who live in the area within a 10-20km radius…. To make sure of it, we expanded the evacuation area to a 20km radius from the viewpoint of making absolutely sure". Under this announcement, the mayor of Tsushima in Namie town located within the 30km radius knew of explosion at Unit 3 on 14 March, and decided to recommend voluntary evacuation from 15 March. However, the

SPEEDI calculation on 15 March predicted a broad diffusion of radioactive materials in the northwestern region on 15 March when the residents in the Tsushima area were evacuating. Almost all of the released radiactive materials following the accident of Fukushima Daiichi NPS are considered to be due to the destruction of nuclear facilities of Units 1 to 3 on 12-15 March, which flowed to the northwestern area, including Iidate village, according to the wind direction and caused an accumulation of the radioactive materials.

In the emergency preparedness guideline, an index to decide on evacuation or stay-indoors instructions was "predicted dose of radiation to be exposed if no measures are taken or radioactive concentration in foods as an actually measured value". The "SPEEDI" was used to calculate the predicted dose, but this information could not be used in the decision to implement the evacuation instruction.

Request for voluntary evacuation

On 25 March, the government received the following advice from the nuclear safety commission (NSC) "It is desirable to facilitate active voluntary evacuation for people living in the area where the ambient dose is relatively higher among the stay-indoors area of 20-30km radius" "It is also desirable to let the other people voluntarily evacuate from the viewpoint of precaution". The government announced "We will actively facilitate voluntary evacuation in the area of 20-30km radius".

The concept of "voluntary evacuation" is not in the guideline of emergency preparedness. According to an interview with Deputy Chief Cabinet Secretary Mr. Tetsuro Fukuyama, it was said that the terminology of "voluntary evacuation" was firstly produced during a discussion on evacuation among Chief Cabinet Secretary Edano, Special Advisor to the Prime Minister Terada, Deputy Chief Cabinet Secretary Fukuyama, Prime Minister Kan, METI Minister Kaieda and Special Advisor to the Prime Minister Hosono. They decided a judgment that people who had the means for evacuation and could move by themselves and ensure a location to evacuate to should be immediately evacuated, and people who could not move by themselves in the area of the 20-30km radius should stay indoors under the risk of the next explosion, because there was a possibility to cause panic when deciding the order for getting on the buses provided by the government.

The government described for the reason why they kept "voluntary evacuation" instead of an evacuation instruction, "It was for the purpose of avoiding misrecognization as increased danger". However, "voluntary evacuation" was ambiguous and caused the residents much anxiety because there was no detailed explanation. This issue was particularly observed in municipalities (e.g., Tamura city) where evacuation, stay-indoors, and the other areas were mixed. There were many residents who felt that this request of voluntary evacuation was irresponsible.

Voluntary evacuation is not addressed in the guideline of emergency preparedness, which caused anxiety for the residents who did not have sufficient information and was seriously criticized because it was a shift of responsibility to leave the judgment of evacuation to the residents themselves. Henceforward, such an evacuation instruction should not be announced as a protective measure in an emergency.

[Nongovernmental Report] Part 2 Chapter 5 Section 4

(b) Communication of measures of evacuation and stay in house

c. How evacuation orders were communicated

The NE Response Manual prescribes that the head of Local Headquarters shall communicate an evacuation order to each municipality including cities, towns and villages.

In fact, however, immediately after the earthquake, communication by telephone proved to be difficult. Moreover, the relevant personnel were unable to reach the Nuclear Emergency Response Local Headquarters (Local NERHQ). Thus it was decided that a new communication route through the Fukushima Prefectural Office and another one through the Secretariat of the NERHQ be added to the Local NERHQ communication route.

However, most of the municipalities actually learned of the evacuation orders through the mass media including TV since it took a long time for a telephone call to get through. Some learned through the verbal announcements by police vehicles, including police patrol cars.

The cities, towns and villages communicated with citizens in the area by using a municipal disaster management radio communication network, sound trucks, police cars, and by fire fighters making door-to-door visits.

In addition, when an evacuation order went out to residents in the area within a 3km radius of the Fukushima Dai-ichi NPS on March 11, nearly all of the residents had already evacuated outside a 3km radius. At 00:30 the next day, March 12, the Emergency Operators Team confirmed that all the residents within a 3km radius had been evacuated (the team confirmed that again at 01:45).

[Governmental Interim Report] Chapter V 3

4.2.2 Problems with the actual evacuations from the residents' perspective

1. Timing of when residents became aware of evacuation orders

The national government expanded the evacuation zone in incremental phases after the accident, after which each evacuation order was promptly communicated to residents by the local governments.

For instance, in Futaba Town, Okuma Town, and Tomioka Town—where many of the municipalities within the 10km radius zone of the Fukushima Daiichi Nuclear Power Plant were located—approximately 80 percent of the residents became aware of the issuance of the evacuation order by about 09:00 on March 12, which was approximately three hours after the evacuation order was issued (just before 06:00). Moreover, in terms of Namie Town, an evacuation order was also communicated in a timely manner to residents living within the 10km radius zone.

In Naraha Town, where the Fukushima Daini Nuclear Power Plant is located, a decision was made to evacuate all residents at 08:00 on March 12, even before the issuance of the evacuation order by the national government: 80 percent of the residents had become aware of the evacuation order at around 10:00 Similarly, while the village office for Katsurao Village had issued its own evacuation order to all residents of the village at 21:00 on March 14, prior to the issuance of the evacuation order by the national government, 90 percent of the residents came to know about the evacuation order immediately after that. In this case, the communication of evacuation orders was also extremely prompt.

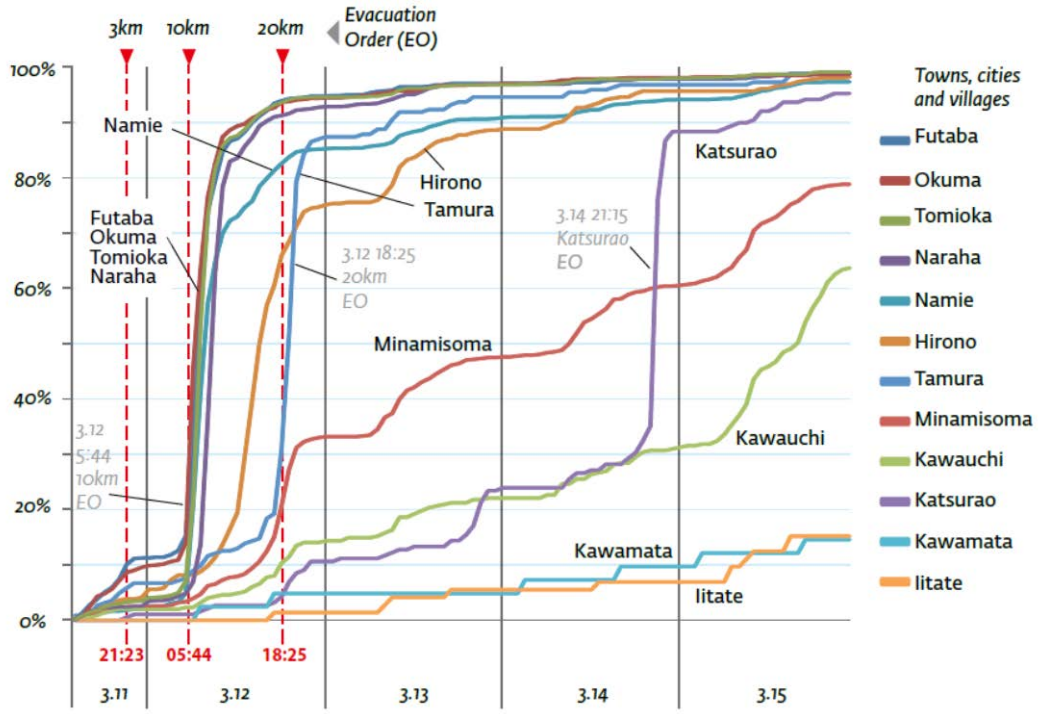

Fig. 4.2.2-1 Percentage of residents who had knowledge of the respective evacuation orders (100 percent: Residents who were evacuated)

2. Sources of information about the evacuation orders

The main source of residents' information about the evacuation orders were communications from the local governments. This fact indicates the local governments' highlevel ability to transmit information to residents.

In Naraha Town and Katsurao Village, where the local governments had decided to evacuate residents even prior to receiving evacuation orders from the national government, 70 percent of the residents learned about the evacuation orders through communications from the local governments. Even in many other municipalities that fell within a 20km radius of the Fukushima Daiichi Nuclear Power Plant, 40 percent to 60 percent of the residents also came to know about the issuance of respective evacuation orders through local governments or other local sources (such as the emergency municipal radio communication system and the police). The proportion of residents who learned about the issuance of respective evacuation orders through the mass media, such as from television broadcasts, stayed within the range of 10 percent to 20 percent.

On the other hand, in those municipalities that included areas designated as Deliberate Evacuation Areas since April, including Minamisoma City, Iitate Village and Kawamata Town, approximately 40 percent of the residents learned about the evacuation orders through the mass media, such as from television broadcasts.

In contrast, there were serious problems in the communication of evacuation orders from the national government to local governments. The only municipalities that were able to receive the evacuation order communications from the national government were Futaba Town, Okuma Town, and Tamura City; in contrast, Tomioka Town, Naraha Town, Namie Town, Hirono Town, Minamisoma City, Kawauchi Village, and Katsurao Village were either unable to receive the evacuation orders from the national government, or had issued evacuation orders to residents at their own discretion based upon their assessment of the situation through news reports and other sources prior to the national government's issuance of evacuation orders. On one hand, the communication of evacuation orders from local governments to residents could be evaluated as extremely prompt, but on the other hand it could also be said that the emergency communications from the national government to the respective local governments had mostly failed to function.

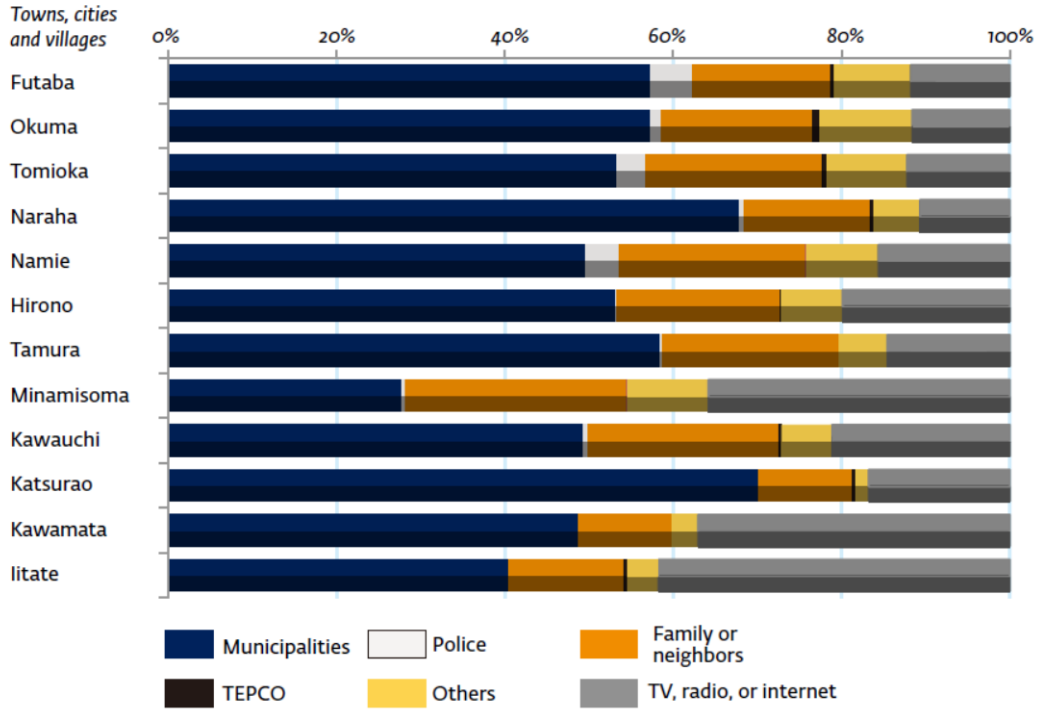

Figure 4.2.2-2: Sources of information for evacuation orders

[National Diet Report] Chapter 4, 4.2.2

(c) Implementation and cancellation of measures of evacuation and stay in house

3. Time of evacuation

After the local governments issued evacuation orders to the residents, the evacuation operation was carried out promptly.

Of the residents in Futaba Town, Okuma Town, and Tomioka Town, where many areas fell within the 10km radius zone from the Fukushima Daiichi Power Plant, 80 percent to 90 percent began to evacuate several hours after the local governments issued the evacuation order. In Namie Town, similar trends were observed in the areas that fell within the 10km radius zone. In Naraha Town, the local government decided to evacuate all residents at 08:30 on March 12, and 80 percent of the residents began to evacuate within several hours of the decision's announcement. Similarly, in Katsurao Village, owing to the issuance of an evacuation order at the village's own discretion at 21:15 on March 14, 90 percent of the residents had evacuated by midnight of the same day.

In the towns of Tamura City and Hirono Town, close to 80 percent of the residents began to evacuate several hours after the issuance of evacuation orders by the local governments. In Kawauchi Village and Minamisoma City, where both municipalities fell within the 20km radius zone and many residents were ultimately forced to evacuate, approximately 20 percent to 30 percent of the residents had been evacuated as of March 12, when evacuation orders were issued for the 20km radius zone; the proportion of residents who were evacuated on a voluntary basis increased gradually thereafter.

In Iitate Village and Kawamata Town, which were designated as a Deliberate Evacuation Area in April, a large number of residents were not evacuated as of March 15. As to the 30km radius zone, a shelter-in-place instruction was issued at 11:00 on March 15, and residents were requested to evacuate on a voluntary basis on March 25. In fact, the residents had successively elected to evacuate on a voluntary basis without waiting for the evacuation order from the national government.

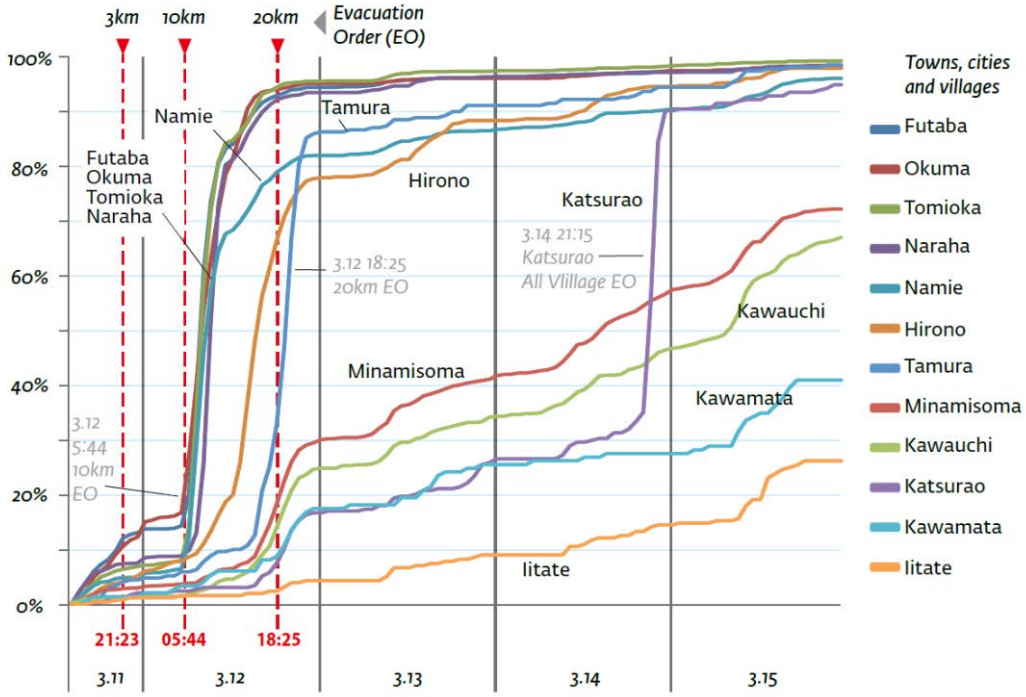

Figure 4.2.2-3: Percentage of evacuated residents

(Omission)

In every press conference, then Chief Cabinet Secretary Edano described all evacuation and shelter-in-place orders to residents as “precautionary measures” and “measures taken to provide utmost assurance.” He did not explain how far the accident situation had actually progressed or speak about the future outlook of the situation at the time.

Our view is that there was a need for the government to provide, at the very least, some explanation of the situation to residents, addressing the sense of anxiety among the residents rather than relying on bland generalizations in phrases like “precautionary measures” or “measures taken to provide utmost assurance.” It was necessary in particular to explain the future outlook of the nuclear reactors, even if the forecasts were preliminary, and to inform residents about the approximate duration of their evacuation. It was also necessary to explain how to prepare for evacuation—after informing them about what was known and as yet unknown regarding the conditions at the nuclear power plant—in order to contribute to a better understanding and assessment of the situation among residents.

As evidenced in the quotes above, residents expressed a strong sense of dissatisfaction with the contents of the evacuation orders. The clear reality is that the government and the Nuclear Emergency Response Headquarters (NERHQ), failed to respond to residents’ needs for useful information about their evacuation in issuing the evacuation orders at the onset of this accident.

5. Expansion of the evacuation zone and phased evacuation

a. A number of evacuees relocated more than six times

According to the survey conducted by the Commission, more than 20 percent of the evacuees from Futaba Town, Okuma Town, Tomioka Town, Naraha Town, Hirono Town and Namie Town, all of which are municipalities close to the Fukushima Daiichi Nuclear Power Plant, relocated more than six times. This was mainly because the government expanded the evacuation zone, in phases, from a 3km radius zone, to a 10km radius zone, and then to a 20km radius zone, putting a heavy burden on the residents.

This point was also brought up in a large number of opinions in the free-answer section of the survey received from residents, notably from those of Okuma Town, Tomioka Town, and

Minamisoma City. These opinions pointed out that residents relocated from shelter to shelter, and were evacuated to new locations several times.

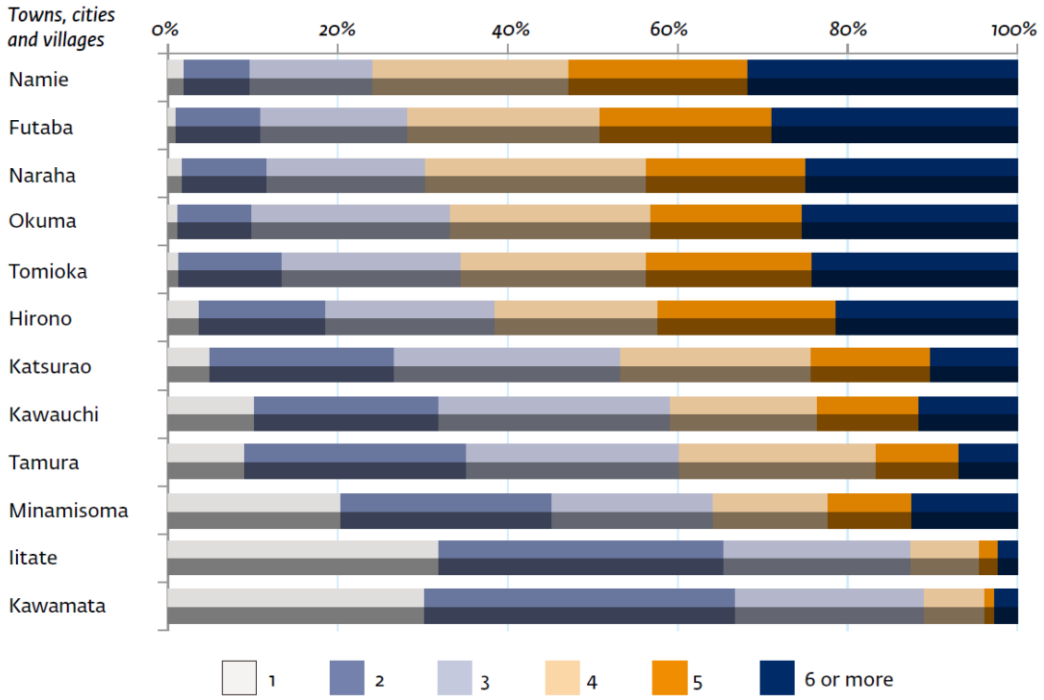

Fig. 4.2.2-4 Number of times that evacuees from each municipality relocated during March 2012

(Omission)

b. Would it have been better to issue evacuation orders for a wide area in advance?

With regard to the phased evacuation, two main questions were raised.

(i) Would it have been possible to prevent the large number of relocations if the government had designated a wider evacuation zone of 20km radius from the Fukushima Daiichi plant at the outset, rather than issuing evacuation orders in phases?

Haruki Madarame, Chair of the Nuclear Safety Commission (NSC), has pointed out that it is necessary to consider the problem of shadow evacuation when the government designates evacuation zones. Shadow evacuation is a problem that occurs when residents in areas that do not require evacuation overreact to evacuation orders. This may give rise to road congestion, which may in turn cause delays in the evacuation of residents from areas that actually require it. With regard to the phased evacuation that was carried out, Madarame asserts that, although the evacuation areas had been designated in phases after only considering the situation of the nuclear power plants, in hindsight, the decision had been "correct" with respect to preventing the shadow evacuation, however inadvertently.

Hypothetically, given the limited number of evacuation routes, if evacuation orders had been initially issued for areas within a 20km radius of the power plants, delays would have been expected in the evacuation of residents from areas closer to the nuclear power plants, where the need for immediate evacuation was most urgent. In that sense, we cannot necessarily assert that it would have been better to issue evacuation orders at the onset of the accident for areas within a 20km radius of the power plants.

In fact, among the opinions in the free-answer section of the survey received from residents of Futaba Town and Tomioka Town, located near the nuclear power plants and where residents had begun to evacuate at the very onset of the evacuation phase, are the complaints of many residents that because the road congestion and road conditions were so serious, it had taken a very long time

to reach their evacuation shelters.

(ii) Would it have been possible to prevent the phased evacuations if the first evacuation order had designated the evacuation shelters in the areas outside of the 20km radius zone from Fukushima Daiichi plant?

According to the Fukushima Prefecture Regional Disaster Prevention Plan (Nuclear Emergency Response Section) (Prefecture Regional Disaster Prevention Plan), each of the municipalities located within a 10km radius (equivalent to the Emergency Planning Zone, or EPZ.) of a power plant is expected to possess regional disaster prevention plans and evacuation plans. According to the Prefecture Regional Disaster Prevention Plan, in relation to its responsibility for formulating the regional disaster prevention plans and evacuation plans, each municipality is, as a rule, primarily responsible for formulating evacuation plans and implementing these plans, but in the event of evacuation over a wider area (across municipalities), Fukushima Prefecture bears the responsibility of formulating an evacuation plan.

However, in reality, Fukushima Prefecture did not anticipate the need to fulfill this responsibility, so in its response to this accident, the prefecture rarely played a leading role in the preparation for wider-area evacuations. The only evacuation cases in which Fukushima Prefecture took the lead in coordinating shelters across municipalities were for Futaba Town and Okuma Town, when an evacuation order was issued for areas lying within a 10km radius from the Fukushima Daiichi Nuclear Power Plant (Fukushima Prefecture designated evacuation shelters in Kawamata Town for the residents of Futaba Town, and in Tamura City for the residents of Okuma Town).

As a result, the initial designation of evacuation shelters, even across municipalities, was relegated primarily to the towns and villages. Therefore, in some cases, the first evacuation destinations were shelters within the same town or village, where evacuations were carried out in a context in which details of the circumstances at the nuclear power plants were not being communicated to the residents. If it had been possible for Fukushima Prefecture to take the lead in responding to the evacuation of residents with foresight, such as by designating evacuation shelters and guiding evacuees to areas outside the 20km radius zone at the initial phase of evacuation, it might have been possible to ease some of the burdens on residents that experienced the phased evacuation. Inadequate foresight and preparation for wider-area evacuation in the Prefecture Regional Disaster Prevention Plan was one cause of the confusion during the residents' evacuation.

6. Destruction of the livelihoods of residents caused by the long-term shelter-inplace orders

a. Impact of shelter-in-place orders on residents

After the issuance at 11:00 on March 15 of the shelter-in-place order to residents living within a 20-to-30km radius from the Fukushima Daiichi plant, residents, other than those who evacuated voluntarily, stayed indoors continuously over a ten-day period until a new request to voluntarily evacuate themselves (unofficial governmental instruction) was released on March 25. Thus, the residents who did not evacuate voluntarily, even after March 25, were forced to remain indoors for more than a month until the shelterin-place orders were lifted on April 22. The areas subject to such shelter-in-place orders included parts of Minamisoma City, Iitate Village, Namie Town, Katsurao Village, Tamura City, Kawauchi Village, Naraha Town, Hirono Town, and Iwaki City.

Staying indoors for a long period of time destroyed the livelihoods of residents through the stoppage of logistics and commerce, particularly in Minamisoma City, Iwaki City, Tamura City, and Iitate Village.

(Omission)

b. Shelter-in-place was originally intended to be a short-term measure

Originally, having residents shelter-in-place was assumed to be a short-term measure. The longer residents were forced to shelter-in-place, the more difficult their lives would become.

The shelter-in-place orders were only aimed at keeping residents indoors during the period of

time when a radioactive plume (cloud) is passing. We can conclude, by interpreting the "Emergency Preparedness for Nuclear Facilities" (Emergency Preparedness Guide) drawn up by the NSC, that the effective duration of this measure is not expected to span as long as ten days.

The appropriate number of days for residents to stay indoors under a shelter-in-place order is assumed to be a maximum of two days, in accordance with the international consensus from which the Emergency Preparedness Guide takes reference, although it is not clearly stipulated in the Emergency Preparedness Guide. Since the Emergency Preparedness Guide was formulated with reference to the international consensus, the Emergency Preparedness Guide is in principle considered to be based upon a similar stance. As the need for shelter-in-place orders was assumed to last only for a short period, little thought had been given in the Emergency Preparedness Guide to a situation in which commerce and logistics come to a standstill. From the perspective of the residents, it is necessary for the government either to implement measures aimed at securing the daily livelihoods of residents when shelter-in-place orders are extended over a longer duration, or to provide an estimate of the forecasted duration of shelterin-place orders when such orders are issued.

In this case, no indications were given to the residents regarding the expected duration of the shelter-in-place orders when they were issued on March 15 for residents living within the 20km to 30km radius zone. Consequently, residents lost access to necessary lifelines when logistics and commerce halted. Although the secretariat of NERHQ/NISA's support to residents subject to shelter-in-place orders commenced, at the latest, on March 21, only insufficient relief supplies were provided. The attention and care given by the national government toward supporting the residents' lives was completely inadequate.

[National Diet Report] Chapter 4, 4.2.2

4.2.3 Evacuation of all hospital patients

Immediately after the accident, people who had difficulty evacuating—such as hospitalized patients—were left behind in the area within a radius of 20 kilometers from the nuclear plant, which had been designated an evacuation zone or Restricted Area. In the chaos immediately following the earthquake, sufficient government assistance was not provided to these hospitals, so medical professionals had to single-handedly search for a means of evacuation and to secure hospitals that would accept the transfer of hospitalized patients. In a situation where communication was limited and sufficient information could not be obtained, the evacuation of hospitalized patients was extremely difficult, resulting in many cases of aggravated medical conditions or death. All the hospitalized patients and medical professionals in these hospitals were forced to bear an enormous burden in the process of evacuation. The worst situations were faced by seriously-ill patients in hospitals that could not secure transportation methods that would not be injurious to patients or evacuation shelters with medical equipment at an early stage. We must conclude that the reasons these situations arose were flaws in the disaster prevention plans of local governments and medical institutions, both of which had not anticipated a large-scale nuclear disaster that would require the establishment of a wide range of evacuation zones.

The Prefecture Regional Disaster Prevention Plan was formulated only in anticipation of an accident of a similar scale to that of the JCO accident; as a result, hospitals were supposed to create their own evacuation plans and implement the evacuation single-handedly. Since the scale of the accident at the Fukushima Daiichi Nuclear Power Plant vastly exceeded what had been anticipated, hospitals were unable to secure both evacuation shelters and means of evacuation single-handedly; however, Fukushima Prefecture and the local municipalities were only passively involved in the evacuations of hospitalized patients. The reason why the evacuation orders in this accident imposed an excessive burden on the hospitalized patients is that Fukushima Prefecture and municipalities were unprepared for this scale of nuclear disaster.

[National Diet Report] Chapter 4, 4.2.3

4. Verification – why the evacuation of patients was extremely difficult

In the Regional Disaster Prevention Plan for Nuclear Emergency Preparedness, the evacuation of the residents living within a 3 km radius was preassumed and the evacuation of a broad area within a 10 or 20 km radius was not previously assumed. The reasons for the difficulty of the evacuation of the patients in hospitals around the NPS are arranged below from five viewpoints, communication of the evacuation information from the government or relevant organizations, communication tools, contact system of the police and Self-Defense Forces, reservation of the conveyance means and reservation of accommodation destinations for patients after evacuation, which were necessary to respond to this situation on the basis of preassumption.

(4.1) Communication of evacuation information from the government and its relevant organization

It is necessary for the judgment of "evacuation of all inpatients" to obtain the information from reliable sources rapidly and surely because of risks during their transportation.

As mentioned above, in Fukushima Prefecture's Regional Disaster Prevention Plan for Nuclear Emergency Preparedness, it is stated that regional medical organizations should receive information on evacuation from the city, town or village. However, in reality, although some residents heard the evacuation instruction through the emergency municipal radio communication system, none of the hospitals received information directly and individually from the city, town or village. Hospitals relied on the TV news, visited the local government and the Off-site Center, and directly got information from policemen who came to the hospital to clarify the situation.

The reason why the communication of information was confused is considered to be a failure in communicating information from the sources, that is, TEPCO, the government and the prefecture, to the local government.

In the case of the Fukushima Dai-ichi NPS, the Off-site Center was located in Okuma city and the alternative facility was the Fukushima Prefectural Government Minamisoma Office. However, as both facilities were damaged by the earthquake, after that, the function of the Off-site Center was transferred to the prefectural office.

The rescue team was established in the Prefecture Nuclear Emergency Response Center just after the accident. The team consisted of twenty and a few staff and responded night and day. The leader of the team in the center, who is the successor of the leader just after the accident, said "There is no fact that evacuation instruction was individually issued by the prefecture for seven hospitals which was located within 20km radius. It is natural to recognize that the evacuation instruction for hospitals was included in the governmental instruction of evacuation for the residents. The hospitals were seeking the place by themselves to allow the transportation after evacuation. We, the rescue team, continued various works including radiological tasks such as preparedness for screening survey in an emergency and distribution of stable iodine, ensuring the evacuation places, setting up temporary toilets and first-aid stations, preparedness for distribution of medicines to medical organizations and the first-aid stations, and responses to the DMAT (Disaster Medical Assistance Team). Information collection was carried out using various routes, such as from the police and the hospitals. On 13 March, we clarified how many patients remained in the hospitals and which hospitals they were in, but there were no records about the evacuation instruction. Although we knew the number of the patients, we did not know whether they could walk by themselves or not. We responded to them instantly."

The municipality also experienced much difficulty in collecting informations. According to the Okuma town Nuclear Emergency Response Center, there was a system to gather emergency staff, which enables relevant staff in the Off-site Center and to communicate with local governmental staff via a mobile phone conference call system. However, in the present accident, this system failed because the Off-site Center was seriously damaged and suffered from a power failure as mentioned above. For this reason, it is said that Okuma town immediately sent their staff to the Off-site Center after the disaster on 11 March.

In Okuma town, the subsequent evacuation instructions for the residents within a 2-3km radius on 11 March were announced by the TEPCO staff who came to the town office. As the first information on the evacuation instruction for the residents within a 10km radius, which was, out of assumption was obtained from a policeman in a local police substation, the Okuma town

requested confirmation from the Futaba police station, and directly confirmed it with the prefecture.

(4.2) Communication tools

After the earthquake, mobile and fixed phones in almost all the affected areas failed, which led to the situation that one call was successful after 20-30 of attempts. In the case of the Futaba Public Welfare Hospital, a professor, who was an expert in the field of emergency medical care from the Fukushima Medical University, in the Prefecture Nuclear Emergency Response Center decided the evacuation of the serious cases by phone attempting to the hospital thirty to forty times. According to the professor, at that time, there were probably three satellite phones in the Prefecture Nuclear Emergency Response Center, but there was no opportunity to use them as they were in use by the relevant staff.

Originally, for example, in the case of Okuma town, there was no system to communicate by satellite phone as a backup function in the Regional Disaster Prevention Plan.

(4.3) Communication system between the police and the Self-Defense Forces

Many hospital staff that faced emergency evacuation testified as follows: “It seems that there was no collaboration between the police and the Self-Defense Forces and they acted independently”. Even though there were wireless tools available to both the police and the Self-Defense Forces, they communicated through the Prefecture Nuclear Emergency Response Center and not directly communicated each other. This is due to a rule that a prefectural governor orders to the Self-Defense Forces in an emergency.

The rescue team in the Prefecture Nuclear Emergency Response Center explained “It is known that the police and the Self-Defense Forces communicated through the Prefecture Nuclear Emergency Response Center, but it is unknown whether or not they also directly communicated each other. This may be an inference. We cannot guess whether each party communicated with each other taking into consideration chain of command of each party”. The lack of direct communication between the police and the Self-Defense Forces led to confusion of the information and the responses. The most typical example is the case of the transportation of the patients in Futaba Hospital.

(4.4) Ensuring tools for transportation

In spite of the decision to evacuate upon receiving the evacuation instruction, there were difficulties in ensuring transportation tools for patients in many hospitals. The tools were motor coaches, vehicles and a helicopter belonging to the Self-Defense Forces, and ambulances and hospital staff’s cars. Ambulances were necessary for the transportation of the serious cases, but motor coaches were the main tool for the transportation because the number of ambulances was limited. “We informed the Self-Defense Forces of the number of hospitals and patients that required resque, but this information was provided by area and we did not provide details of specific hospitals. The evacuation was also necessary for not only patients in hospitals but also members in facilities for seniors and handicapped people, and general public” (said by a member of the rescue team in the Prefecture Nuclear Emergency Response Center).

The hospitals repeatedly requested the prefecture, the town and the local police to ensure the tools for transportation of the patients. However, as seen from the failure of the communication of the evacuation instruction, the requests from hospitals were not immediately informed and not responded to at once. For example, in the case of Futaba hospital, a director of the hospital drove a car by himself and repeatedly made requests for rescue to the policemen and the members of the Self-Defense Forces that he met on the road, since all the staff in Okuma town evacuated just after the explosion of Unit 3 at 15:36 after the first evacuation started at 14:00 on 12 March. However, the next rescue vehicle came there at about 9:00 on 14 March, which was a serious delay. Moreover, at Imamura hospital, the director of the hospital made requests for rescue through the prefectual police because they refused to prepare an ambulance. In Kodaka Akasaka hospital, they firstly heard that buses for evacuation would be supplied by the Self-Defense Forces, but the buses never arrived there, and they finally evacuated using buses provided by the Niigata prefectual

police.

(4.5) Ensuring accommodation for the patients after evacuation

Minamisoma Municipal City Odaka Hospital is the only hospital that had already decided organized a place for evacuation before the patients left the hospital, although no method of transportation of the patients could be found. “As the reasons why the transportation was rapidly possible without deaths, the following three points are raised; 1) an Odaka ward office was nearby, 2) there were many staff in Odaka hospital, which was not damaged by the earthquake and 3) Minamisoma Municipal City General Hospital was nearby” (manager of Minamisoma Municipal City Odaka Hospital). A second evacuation was needed because Minamisoma Municipal City General Hospital was located 23km from Fukushima Dai-ichi NPS. In the other hospitals, there was no information about the destination of the transportation when the patients were taken from the hospital. In addition, the destination of the first evacuation was the same place as that for the general residents. It was a bad environment, that is, it was difficult to provide medical care. For this reason, the hospital staff searched for a new hospital using their personal connections. There were few cases in which the government was involved in the search.

(d) Designation of deliberate evacuation zone and specific spots recommended for evacuation

d. Establishment of deliberate evacuation zones and emergency evacuation preparation zones

In the NE Guideline, it is not assumed that a stay-indoors evacuation is carried out for a long period of time. As per the description above, the results of radiation monitoring and SPEEDI retrospective estimation showed there were areas with high levels of radiation dose even in areas more than 20km from the Fukushima Dai-ichi NPS. The distribution of essential items was interrupted in stay-indoors evacuation zones and it was hard for residents to conduct their daily lives. In response, from March 31, the NERHQ started further discussions on additional evacuation zones based on estimation results of the annual cumulative dose that had been created by MEXT.

In this discussion, it was decided that actual measurement data should be used for the cumulative dose between the start date and the latest date of measurements, values corrected by SPEEDI simulation results should be used for the cumulative dose before measurement started, the latest actual measured values should be used for the cumulative dose after the latest measurement date for the conservative purpose, and then the cumulative dose over a year from the nuclear accident was decided to be estimated, and all these results were decided to be mapped.

In addition, the guidelines in the NE Guideline stating that "stay-indoors evacuation orders shall be issued if the cumulative dose is 10mSv or more, and evacuation orders if 50mSv or more" might be appropriate for incidents where radioactive material is released for a relatively short period of time. But these indices might not be appropriate for the current nuclear accident where there has been an extended period of exposure to radioactive materials accumulated on the ground. Hence, it was decided to take the lowest limit of 20mSv out of the range from 20mSv to 100mSv which ICRP defined as indices for the evacuation under the nuclear emergency situation. It was decided that residents in an area higher than 20mSv/year should be evacuated according to the evacuation program, and residents in an area lower than 20mSv/year should be prepared to begin evacuating or follow a stay-indoors evacuation order at a nuclear emergency, assuming a worst case scenario for the conservative purpose, even if a hydrogen explosion is less likely due to the filling of nitrogen.

On April 10, the NERHQ officially asked the NSC for their advice on the evacuation strategy for residents living in (i) areas beyond a 20km radius of the Fukushima Dai-ichi NPS that had high levels of radiation dose, and (ii) areas beyond a 20km radius of the Fukushima Dai-ichi NPS with a probability of high levels of radiation dose at the emergency.

On the same day, in response to the request of NERHQ, the NSC proposed the following advice: with regards to (i), areas beyond a 20km radius of the Fukushima Dai-ichi NPS (including areas beyond a 30km radius) where cumulative dose may reach 20mSv within the period of one year from the date of the nuclear accident shall be designated "deliberate evacuation zones"; areas that are in stay-indoors evacuation zones within a 20 to 30km radius but outside deliberate evacuation zones shall be designated "emergency evacuation preparation zones"; and residents should always be ready and able to follow a stay-indoors evacuation order or evacuation order at the emergency. In addition, even residents in emergency evacuation preparation zones are advised to begin voluntary evacuation. Because it is anticipated that it may be difficult to complete evacuations swiftly in an emergency situation, it is strongly recommended that children, pregnant women, those who require nursing care and hospitalized patients should not enter these areas.

On April 11, based on the advice of the NSC, Chief Cabinet Secretary Edano announced a fundamental concept of how deliberate evacuation zones and emergency evacuation preparation zones should be established.

Subsequently, the government issued early advice to the affected municipalities and then, on April 22, based on "Estimated Values of Cumulative Dose Based on Actual Measurements" concerning zones beyond a 20km radius of the Fukushima Dai-ichi NPS, which was prepared by MEXT on April 10, the NERHQ established deliberate evacuation zones and emergency evacuation preparation zones pursuant to the provisions of Article 20, Paragraph 3 of the Act on Special Measures Concerning Nuclear Emergency Preparedness. In addition, the NERHQ provided those municipalities with a directive to tell residents in the former zones to be prepared to leave their homes in an evacuation after a period of approximately one month, and those in the latter zones to always be prepared to either evacuate from their homes at the emergency or to be prepared to begin a stay-indoors evacuation. Further, the stay-indoors evacuation order to residents in areas within a 20 to 30km radius of the Fukushima Dai-ichi NPS was lifted.

(Omission)

f. Establishment of specific spots recommended for evacuation

By April 22 when deliberate evacuation areas and emergency evacuation preparation zones had been established, spots where annual cumulative radiation dose might exceed 20mSv assuming that the radiation dose levels continued afterwards had been found in parts of Date-city and Minami-soma-city. However, the distribution of these spots was not understood for an extended area, but for a limited area. Hence, the Government Emergency Response Center did not designate those entire areas including these points as deliberate evacuation zones. Instead, they decided to take a wait-and-see approach to observe how radiation dose might decrease with time by monitoring them over time.

Subsequently, however, on June 3, MEXT estimated cumulative radiation dose and found that there were spots where the estimated annual cumulative radiation dose for one year after the nuclear accident might exceed 20mSv of a criteria for deliberate evacuation zones, in parts of Date-city and Minami-soma-city, which are located outside the deliberate evacuation zone.

In response to this fact, the NERHQ discussed the adoption of concrete measures for locations where spots with high radiation dose were found in some areas and created a guideline referred to as "Response to specific spots estimated to exceed an integral level of exposure of 20mSv over a one-year period after the accident." The guideline stated that spots where the estimated annual cumulative radiation dose over a one-year period after the nuclear accident might exceed 20mSv should be designated as "specific spots recommended for evacuation," and that the NERHQ should notify all residents living in these spots and assist and support their evacuation. On June 16, the NERHQ asked the NSC for its advice on this guideline. That same day, the NSC responded to this request replying to the effect that it had no objection to the NERHQ’s ideas, although it might be necessary to consider possible ways to solve this problem without conducting an evacuation, including finding ways to decontaminate the areas that were only partially contaminated with high concentration of radioactive materials.

Based on this advice, the NERHQ decided that the spots where the estimated annual cumulative

radiation dose over a one-year period might exceed 20mSv should be designated as specific spots recommended for evacuation. That same day, Chief Cabinet Secretary Edano released a statement to that effect.

It was decided that the Local NERHQ should specify spots, per house, where decontamination is not easy and are estimated to exceed 20mSv/year, through mutual consultation between the Fukushima prefectural government and the cities, towns or villages where those spots are located. Through mutual consultation with the respective municipal governments, the Local NERHQ designated parts of Date-city on June 30 and November 25, parts of Minami-soma-city on July 21 and August 3, and parts of Kawauchi-village as specific spots recommended for evacuation.

Additionally, specific spots recommended for evacuation have not been issued with evacuation orders pursuant to the provisions of Article 20, Paragraph 3 of the Act on Special Measures Concerning Nuclear Emergency Preparedness. This policy is based on the idea that specific spots recommended for evacuation are not dangerous enough to instruct all residents to begin evacuation since radiation levels will be minimal if residents leave the area, and that the government will provide information to alert them to the possibility of radiation exposure and support residents if they need to be evacuated.

[Governmental Interim Report] Chapter V 3

9. Establishment of the Deliberate Evacuation Area

The following is an overview of the course of events behind the establishment of the Deliberate Evacuation Area.

On March 15, the NERHQ issued shelter-in-place orders to residents within a 20-to-30km radius from Fukushima Daiichi Nuclear Power Plant. In the aftermath, the prolonged period of shelter-in-place orders posed numerous problems for the livelihood of residents, and the truth of the degree of contamination over the area gradually became clearer. Nevertheless, the NERHQ neither established a new evacuation zone nor lifted the shelter-in-place order, but rather only urged residents on March 25, 2011 to voluntarily evacuate. On April 22, they finally established the Deliberate Evacuation Area over the area.

The Deliberate Evacuation Area is an area outside the 20km radius from the Fukushima Daiichi Nuclear Power Plant, where there was concern that the cumulative air dose might reach 20 mSv within a one-year period after the accident. Residents were encouraged to evacuate to another location within roughly one month's time. The Deliberate Evacuation Area specifically referred to areas northwest of the nuclear power plant with high contamination levels, including some parts of Katsurao Village and Namie Town, all area of Iitate Village, and some parts of Kawamata Town (Yamakiya district) and Minamisoma City.

(Omission)

10. Specific spots recommended for evacuation

The NERHQ established "specific spots recommended for evacuation," with regard to those limited areas facing difficulties in decontamination, outside both the Restricted Area and the Deliberate Evacuation Area, where integral doses were predicted to exceed 20 mSv over one year after the accident. The NERHQ indicated the necessity of cautioning residents in these areas and also assisting and encouraging their evacuation. As a result, the spots designated as "specific spots recommended for evacuation" were 117 points (128 households) in Date City, 142 points (153 households) in Minamisoma City, and 1 point (1 household) in Kawauchi Village as of May 2012.

[National Diet Report] Chapter 4, 4.2.2

Revision of the evacuation area

The government made a revision of the evacuation area on 11 April and implemented the revision on 21 and 22 April. This revision consisted of (1) setting of a restricted area where the violator was fined by law, (2) reduction of the evacuation area from within a 10km to an 8km

radius from the Fukushima Dai-ni NPS, (3) cancellation of the stay-indoors area from a 20 to a 30km radius, (4) setting of the deliberate evacuation area outside of the 20km radius where the residents were required to deliberately evacuate within approximately one month and (5) setting of emergency evacuation preparation zones where residents should always be ready and able to follow a stay-indoors evacuation order or evacuation order in an emergency and are advised to begin voluntary evacuation.

The most important point in this revision was the setting of a deliberate evacuation area in the northwestern region where a high radiation level was observed despite being beyond the 30km radius. However, forty days had already passed since the occurrence of the accident by the time the revision of the evacuation area was implemented. The evacuation area should have been revised as soon as possible. Earlier revision was possible because the diffusion of the radioactive materials into Iidate village was predicted by the SPEEDI after 12 March and there were radiation monitoring data available for the northwestern region.

Moreover, a point to be raised as an issue is that the government did not actively clarify the revision of the evacuation area and stay-indoor area implemented from just after the accident to the end of March. The revision in April was for long-term relocation to avoid the accumulated dose by living for a long time, which was different from the temporary evacuation in the emergency in March. However, this distinction was not clearly shown according to the instruction of the residence office. It may be inevitable to facilitate the evacuation of the residenst after sufficiently preparing and obviously informing the relevant residents of the type of the evacuation that is not temporary but long-term one.

[Nongovernmental Report] Part 2 Chapter 5 Section 4

The following isssues can be raised in association with the evacuation of residents.

Evacuation of residents and its criterion – extension of order to stay indoors

- The results of radiation monitoring and SPEEDI retrospective estimation showed there were areas with high radiation doses even more than 20km from the Fukushima Dai-ichi NPS. The distribution of essential items was disrupted in stay-indoors evacuation zones and it was difficult for residents to conduct their daily lives. In the Nuclear Emergency Guidelines, the enforcement of a stay-indoors evacuation for a long period of time was not assumed.

Evacuation of residents and its criterion – instruction of deliberate evacuation

- On 11 April 2013, Chief Cabinet Secretary Edano announced a fundamental concept of how deliberate evacuation zones should be established. Subsequently, the government issued early advice to the affected municipalities and then, on 22 April, the Nuclear Emergency Response Headquarters (NERHQ) established deliberate evacuation zones and provided those municipalities with a directive to inform residents in the zones to be prepared to evacuate after a period of approximately one month.

Evacuation of residents and its criterion – communication of evacuation instruction

- The Emergency Preparedness Guide prescribes that the head of the local headquarters shall communicate an evacuation order to each municipality, including cities, towns, and villages. Most of the municipalities actually learned of the evacuation instructions through the mass media including TV. Some of them learned through verbal announcements from police vehicles, including police patrol cars.

Evacuation of residents and its criterion – evacuation beyond a designated zone for emergency preparedness

- Each of the municipalities located within a 10km radius (equivalent to the Emergency Planning Zone, or EPZ) of a power plant is expected to possess regional disaster prevention plans and evacuation plans. Each municipality is, as a rule, primarily responsible for formulating evacuation plans and implementing these plans, but in the event of evacuation over a wider area (across municipalities), Fukushima Prefecture bears the responsibility of formulating an evacuation plan. However, in reality, the only evacuation cases in which Fukushima Prefecture took the lead in coordinating shelters across municipalities were for Futaba Town and Okuma Town, when an evacuation instruction was issued for areas lying within a 10km radius.

Evacuation of residents and its criterion – evacuation of socially vulnerable individuals

- People who had difficulty evacuating, such as hospitalized patients, were left behind in the area within a radius of 20km from the nuclear plant, which had been designated as an evacuation zone. In the situation where communication was limited and sufficient information could not be obtained, the evacuation of hospitalized patients was extremely difficult, resulting in many cases of aggravated medical conditions or death.

(4) Radiation exposure

(a) Radiological protection criteria

Overbiew of radiological protection criteria in the Emergency Preparedness Guide are given in **[Governmental Interim Report]** in the following way.

c. Standards in Japan

In Japan, the following standards have been established based on the ICRP recommendations (Pub. 60) issued in 1990.

Firstly, the NSC has set up the NE Guideline (refer to Section 2 (3) b above) as emergency countermeasures against accidents in nuclear facilities.

This NE Guideline formulated the "indices of stay-indoors evacuation and evacuation". A stay-indoors evacuation should be conducted if a predicted effective dose from external exposure

(predicted exposure to radioactive material or radiation while being outdoors during a period of a release of radioactive materials) is 10 to 50mSv, and evacuation (or a stay-indoors evacuation into concrete buildings) should be carried out if the external radiation dose is more than 50mSv.

Secondly, the NE Guideline formulated the "indices of protective measures concerning the intake of stable iodine tablets" as a guideline for taking stable iodine tablets to protect the thyroid gland from radiation exposure. The stable iodine tablets should be applied when a predicted equivalent dose of infant thyroid gland exposure to radioactive iodine is more than 100mSv (in principle for people under 40 years old).

In addition, with regards to food, the NERHQ formulated the "Index for restrictions on the intake of food and beverages" in the table below as a guideline for discussions on whether or not it is necessary to take measures to restrict food and beverages.

Table V-1 Index for restrictions on the intake of food and beverages, unit Bq/kg

Target	Radioactive iodine	Radioactive cesium
Drinking water	300	200
Milk and other dairy products	300	200
Vegetables (excluding root vegetables and tubers)	2,000	-
Vegetables	-	500
Cereals	-	500
Meat, eggs, fish, others	-	500

Prepared based on the guidelines of "Emergency Preparedness for Nuclear Facilities" (first published in June 1980 and last revised on August 23, 2011)

Next, concerning workers engaged in radiation work in radiation controlled areas (hereinafter referred to as "radiation workers"), Japan has formulated "Ionization Radiation Injury Prevention Rules" (hereinafter referred to as "Ionization Rules"), "Rules for Commercial Nuclear Power Reactors concerning Installation, Operation, etc." (hereinafter referred to as "Commercial Reactor Rules"), "Notice on Exposure Limits Based on Provisions of Commercial Power Reactor Rules" (hereinafter referred to as "Commercial Reactor Notice"), and "National Personnel Authority Rules 10-5 (Prevention of Radiation Injuries in Staff)", which states that the radiation exposure dose (hereinafter referred to as "Dose Limit") of radiation workers should be less than or equal to 100mSv/5 years and less than or equal to 50mSv/year based on ICRP recommendations. In this regard, however, it is stipulated that, in emergency situations, the exposure limit shall be 100mSv, in Article 7, Paragraph 2 of Ionization Rules; Article 9, Paragraph 2 of

Commercial Reactor Rules; Article 8 of Commercial Reactor Notice; and Article 4, Paragraph 3 of National Personnel Authority Rules 10-5.

[Governmental Interim Report] Chapter V 4

- Criteria for administration of stable iodide

Descriptions about criteria for administration of stable iodide are given in **[Governmental Interim Report]**, **[Governmental Final Report]** and **[National Diet Report]** in the following way.

e. Distribution of stable iodine

Stable iodine is a chemical that mainly consists of non-radioactive iodine. Taking iodine for radiation exposure can help prevent radioactive iodine from being incorporated into the thyroid gland even after radioactive iodine has entered the body. Thus stable iodine is used to prevent thyroid gland cancer from occurring.

The "guidelines concerning the preventive intake of stable iodine tablets" prepared by the NSC

in April 2002, describes how to determine whether or not stable iodine tablets should be taken stating that "various protective measures can be implemented, including shelter, evacuation and preventive intake of stable iodine tablets, in accordance with the NERHQ' judgment." Additionally, while addressing concerns regarding the side effects of stable iodine, these guidelines also stipulate that great care should be taken to ensure residents take stable iodine tablets as safely and as soon as possible in an emergency situation where it is predicted that the infantile thyroid gland equivalent dose due to radioactive iodine will reach 100mSv, and if the NERHQ instructs residents to take stable iodine as a preventive measure.

The NE Response Manual prescribes that the "Technical Advisory Organization in an Emergency" staff shall provide a technical advice in the "Joint Council for Nuclear Emergency Response" established in the Off-site Center and that a draft of protective intake policy implemented by the Urgent Emergency Measures Policy-making Committee should be reported to the NERHQ, that the NERHQ' decision on the intake of stable iodine tablets should then be communicated by the head of the NERHQ to the head of the Local NERHQ, who should convey this information to the governors of local governments, and finally that the governors of local governments should then provide this information to their residents.

At 13:15 on March 12, the Local NERHQ issued a written order to the leaders of the prefectural government and respective municipalities (Okuma-town, Futaba-town, Tomioka-town, Namie-town) to the effect that "if instructions are issued for residents to take stable iodine tablets, it should be decided by all possible means that stable iodine tablets be distributed to evacuation facilities and that a sufficient number of pharmacists and doctors should be stationed at these evacuation facilities.

Moreover, as described in b above, the Local NERHQ asked the ERC for advice and its comments on a draft that the screening level should be changed to 40Bq/cm^2, or 6,000cpm. In response to this request, the NSC told the ERC that instructions should be given at their screening services to the effect that stable iodine tablets should be provided to those who had radiation dose of more than 10,000cpm. However, this information was not communicated to the Local NERHQ.

On the night of March 14, the ERC medical treatment team was informed that the evacuation of hospitalized patients within a 20km radius had not yet been completed and they provided this information to the NSC. In response, a few hours later at 3:10 on March 15, the NSC provided the ERC advice to the effect that the hospitalized patients should have taken stable iodine tablets when they were evacuated according to a provision concerning "Rules on the intake of stable iodine tablets in the evacuation of hospitalized patients from an evacuation zone (within a 20km radius)." The ERC sent this advice to the Local NERHQ by fax. However, that same day, the Local NERHQ was busy relocating to the Fukushima Prefectural Office building. It was not until later that evening, after they had completed their move, that they discovered the fax conveying this advice. The Local NERHQ, which considered it highly likely that in addition to hospitalized patients many elderly citizens living in local communities and hospital staff still remained, created an instruction draft to the effect that subjects who should take stable iodine should include residents other than hospitalized patients. That night, the Local NERHQ provided the ERC with its instruction draft stating that residents who should take stable iodine tablets should include all citizens that still remained within a 20km radius. In response to this, the ERC asked the NSC for advice on this instruction draft. At 01:25 on March 16, the NSC distributed advice to the ERC to the effect that all of those who remained within a 20km radius should take stable iodine tablets while being evacuated according to the "Rules on having those who remain in evacuation zones (within a 20km radius) take stable iodine tablets when being evacuated." The Local NERHQ, which confirmed this advice via the ERC, issued a written order at 10:35 the same day to the leaders of the Fukushima prefectural government and 12 affected municipalities to "have those who are evacuated from evacuation zones (within a 20km radius) take stable iodine tablets." However, the Fukushima prefectural government did not follow this instruction on the intake of stable iodine tablets because the government had already confirmed that there were no subjects who remained within a 20km radius.

Additionally, the Basic Disaster Prevention Plan stipulates that the "National Government (MEXT and MHLW), Japan Red Cross, local governments and nuclear operators shall cooperate

with each other in storing and maintaining radiation measuring materials and equipment, decontamination materials and equipment, stable iodine tablets, medicinal chemicals and equipment for emergency relief activities, as well as materials and equipment for medical services." Six regional municipalities surrounding the Fukushima Dai-ichi NPS and Fukushima Dai-ni NPS (Hirono-town, Naraha-town, Tomioka-town, Okuma-town, Futaba-town and Namie-town), as per the advice in the "Manual for radiation emergency medical care activities in Fukushima Prefecture," already had 136,000 stable iodine tablets on hand, which corresponded to three doses for the estimated population of intake subjects (below 40 years old) in an EPZ (Emergency Planning Zone), which is a regional zone within a 10km radius requiring enhanced comprehensive disaster prevention planning. Additionally, Iwaki-city and Koriyama-city, which were not designated as EPZ, also stored and maintained stable iodine tablets.

Moreover, the Fukushima prefectural government stored and maintained 68,000 stable iodine tablets in the Environmental Medical Research Institute located in Okuma-town for tourists and other visitors to the prefecture. The local Government also asked the ERC and other organizations to help secure stable iodine tablets and was able to obtain approximately 1,360,000 stable iodine tablets from a major stable iodine manufacturer and from the Ibaraki prefectural government.

On March 14, the Fukushima prefectural government discussed whether or not stable iodine tablets should be distributed to all municipalities within an approximate radius of 50km of the nuclear power station and reached the decision to distribute two tablets to each resident of younger than 40 years old within these zones in each municipality. By March 20, the Fukushima prefectural government had distributed approximately 1,000,000 stable iodine tablets to residents living in municipalities in the Hama-dori and Naka-dori districts.

Additionally, around and after March 15, some regional municipality offices surrounding the Fukushima Dai-ichi NPS distributed stable iodine tablets to their residents of their own accord. For example, on March 15, the Miharu-town town office not only distributed stable iodine tablets to its residents, but also instructed them to take the tablets. In the middle of the night of March 13, Miharu-town town officials learned that the radiation level had increased at the Onagawa Nuclear Power Station. Weather forecasts predicted rain with an easterly wind for the following day, March 15. Miharu-town town officials were afraid that its residents might be exposed to radiation and decided to distribute stable iodine tablets to its residents and instructed them to take the tablets. At 13:00 that day, Miharu-town town officials, using a municipal disaster management radio communication network, made sure that each and every resident was informed of this decision. They distributed stable iodine tablets to approximately 95% of object residents under supervision of the local pharmacists. Later, health and welfare service section staff of the regional medical division of the Fukushima prefectural government learned that the Miharu-town town office had distributed stable iodine tables and instructed intake subjects to take them without directives from either the national or local governments. In the evening of the same day, the section staff instructed Miharu-town officials to stop distributing stable iodine tablets and to recover all of them as there had been no instructions from the national government. Miharu-town town officials did not obey this demand.

[Governmental Interim Report] Chapter V 4

(b) Orders from the government concerning the intake of iodine tablets

On March 13, 2011, the Medical Squad of the Local NERHQ commenced preparations in the morning to issue an order from the Director-General of the Local NERHQ, as mentioned in Chapter IV. 4. (5) b. above, concerning the screening level corresponding to the anticipated radiation exposure limit. During that process, the NSC delivered a FAX transmission at approximately 10:40 of the same day to the ERC with the comment that stable iodine tablets should be administered to those whose radiation contamination exceeded the screening level. A liaison officer dispatched from the NSC to the ERC received this transmission. However, this comment was not shared within the ERC Medical Treatment Squad, and nor was it reviewed in the ERC, and therefore it was not transmitted to the Local-NERHQ, either. This is considered to be the result of a lack of awareness, on the part of the NSC liaison officer, of the importance and

necessity of incorporating the NSC comments into the orders to be issued by the Director-General of the NERHQ. It can be so understood from the grounds that the said liaison responded to the NSC Secretariat over the phone soon after he had received the above fax message from the NSC as "it is too late to alter the existing plan because it is already moving on with the original level," suggesting a difficulty in incorporating the comment in the order, and that the comment was never shared or reviewed in the ERC thereafter.

On the other hand, the staff of the NSC Secretariat who learned from the liaison "it is too late to alter the existing plan because it is already moving on with the original level," conveyed the message to each NSC committee member. The NSC, however, did not give any further advice for the reason, "The NSC is by nature an advisory body. What should be advised is already advised." The NSC indeed is an advisory body but it cannot be denied that the fact that they took no further action but merely stating "what should be advised is already advised" about their own comments which seriously concerned the people's safety reflects the lack of responsibility as an administrative body concerning people's safety.

(c) Orders from the local governments concerning the intake of iodine tablets

As reported in detail in Chapter V. 4. (5) e. of the Interim Report, the Miharu Town administration decided at midnight on March 14, 2011, to distribute and issue orders for the intake of stable iodine tablets, based on an anticipation of residents' exposure to radiation. At approximately 13:00 on March 15, this was announced to the residents of the town over the community radio system or other means, and under the supervision of pharmacists, stable iodine tablets were distributed to 95% of the residents. A staff of the Local Medical Care Division, Health & Hygiene Promotion Office of Fukushima Prefecture who came to know of this fact issued an order in the evening of the day to suspend the distribution and recall the tablets, based on the reason that no instructions had been received from the national government. However, the Miharu Town administration did not comply. Considering the fact that the NSC's opinion about the administration of stable iodine tablets was dismissed as outlined in (b) above, it cannot be concluded that the decision by the Miharu Town administration was inappropriate simply because it had not been backed by an instruction from the national government. In the existing emergency preparedness, administration of stable iodine tablets is, in principle, subject to the judgment of the government nuclear emergency response headquarters (according to the Nuclear Emergency of Response Manual). However, in view of the aforementioned incident, a system which allows local municipalities to independently administer the tablets should be reconsidered, and so is the appropriateness to distribute them in advance to the residents as a precaution.

[Governmental Final Report] Chapter VI 1

4.4.2 Stable iodine that did not work as a protection measure

Radioactive iodine, once it is incorporated in the human body, is accumulated in the thyroid gland, which can cause thyroid cancer. It is thought that stable iodine in the form of iodine tablets can effectively prevent radioactive iodine from accumulating in the thyroid gland. The Guidelines for the Taking of Stable Iodine Tablets as a Preventive Treatment in Times of Nuclear Emergency, released by the Safety Commission, specify general views concerning the taking of iodine tablets as a preventive treatment in times of nuclear emergency. The prefecture's regional disaster prevention plan stipulates that the Prefecture Headquaters for Disaster Control shall give instructions to the people in the prefecture, among others, about the distribution and taking of iodine tablets based on the instructions from the Nuclear Emergency Response Headquarters (NERHQ) or on the decision of the governor of the prefecture.

In the aftermath of this accident, however, neither the NERHQ nor the governor of Fukushima Prefecture gave instructions to take iodine tablets within the period of time in which they would be effective. The NSC's advice about the administration of iodine tablets was ambiguous and whether the NSC's advice reached Fukushima Prefecture and the cities, towns, and villages concerned, has not been confirmed. There were two types of cities, towns, and villages, local

governments that responded to the needs of their respective people: those in which iodine tablets were distributed so the people could take them, and those that did not distribute them but waited for instructions. As a result, many of the people in Fukushima Prefecture were unable to take iodine tablets despite the fact that the cities, towns, and villages in the prefecture had stock.

(Omission)

2. Miscommunication between the central and prefectural governments regarding iodine tablet instructions

The Fukushima prefectural government started the deployment of iodine tablets immediately after the occurrence of the accident so that they could be distributed to its people and instructions could be given to them to take those tablets. They had a stock of iodine tablets for the towns neighboring the nuclear power plants, as well as for the cities, towns, and villages located outside the 50km radius around the Fukushima Daiichi Nuclear Power Plant. From the very beginning, the Fukushima prefectural government moved to fill the gap between the number of iodine tablets needed for these people and the number of iodine tablets they actually had in stock.

The NSC, although they had no information from SPEEDI nor any emergency monitoring data, issued advice on March 13, based on a screening inspection result, that iodine tablets should be taken.

This advice, however, did not reach Fukushima Prefecture and the cities, towns, and villages concerned. The governor of the prefecture, despite having the authority to do so, did not give instructions to each city, town, and village concerned to take iodine tablets.

a. Failure to confirm instructions to take iodine tablets

According to NSC, the medical group of the Prime Minister's Nuclear Emergency Response Headquaters (ERC) and NRC started a meeting at midnight on March 12 to discuss a screening level and confirmed the step to administer iodine tablets to those people with at least 10,000 cpm of radiation.

After 10:00 on March 13, NSC was asked by the Local Nuclear Emergency Response Headquarters (Local NERHQ) for advice on screening instructions to be given to the governor of the prefecture and the mayors of Okuma Town, Futaba Town, Tomioka Town, and Namie Town. NSC sent a fax to ERC. The faxed document shows a handwritten, additional instruction to "set 10,000 cpm of radiation as the criterion for the commencement of decontamination and taking of iodine tablets" when conducting screening. According to a hearing with NSC, a staff member of the NSC Secretariat, who was there working handed this document to a member of ERC, but that document did not arrive at the Local NERHQ Accordingly, the Local NERHQ distributed the instructions, without incorporating NSC's advice, to the prefecture and the cities, towns, and villages concerned.

The instructions, which did not reflect advice of NSC, arrived at NSC the same day. They should have understood at that point that their advice had not adequately reached the affected sites. NSC, however, did not confirm the situation nor did it again give advice.

On March 14, the Fukushima prefectural government raised the screening criterion for decontamination from 13,000 cpm to 100,000 cpm and used that criterion accordingly. NSC judged that if a measured figure showed 13,000 cpm, that would be "equivalent to the thyroid dose of approximately 100 mSv," which would, assuming that all internal exposure is caused by iodine, become "a criterion for commencing the administration of stable iodine." NSC therefore advised against loosening the criterion. The people on the ground, however, were not aware that the screening criterion was in fact the criterion for administering iodine tablets. Again, NSC's advice did not lead to the taking of iodine tablets.

In a hearing, a member of NSC said, "We advised that affected people should take iodine tablets once a measured figure reached 10,000 cpm, so I thought the iodine tablets were being taken accordingly." According to a hearing with NISA, they were unable to "find anyone who had received such a document" in the secretariat of the NERHQ, which in theory should have received written advice about the administration of iodine tablets.

The NSC has explained that the role they are expected to play is "to give advice" and that they "will not be involved in the act of giving instructions or in decisionmaking." In their mind, confirming that the information was received or proposing their opinion is outside the scope of their responsibilities, even if their advice is not reflected in countermeasures.

In the end, the secretariat of the NERHQ and NSC, both of which were in charge of measures against initial exposure through the use of iodine tablets–which was thought to be the most important measure in times of nuclear emergency–did not share recognition with each other nor did they confirm the status of instructions.

b. The governor of the prefecture, who did not give instructions

Meanwhile, the Fukushima prefectural government kept waiting for instructions from the central government. It was through the document dated March 16, in which it was specified that iodine tablets should be administered to the people in the evacuation zone (any place located within a 20km radius) when they evacuate, that the prefectural government first became aware of the receipt of instructions to distribute and take iodine tablets. But the prefectural government was not aware of the existence of the document until March 18. At that point, the evacuation of people living within the 20km radius had already been completed; the Fukushima prefectural government had failed to give instructions to distribute and take iodine tablets.

It was possible for the governor of the prefecture to give instructions to take iodine tablets at his own discretion without waiting for the instructions from the central government. Nevertheless, the Fukushima prefectural government did not deliberate at all about the extent to which it was authorized to make its own judgment concerning the issuance of instructions to distribute and take iodine tablets.

It wasn't that the Fukushima prefectural government lacked the basic information necessary for making an independent judgment to give instructions for distributing and taking the iodine tablets. It was true that, as far as the areas near the nuclear power plants are concerned, only one monitoring post, out of the 24 posts in the prefecture, kept functioning immediately after the occurrence of the earthquake. But the Fukushima prefectural government had received information from SPEEDI and also possessed, albeit not sufficiently, information from the central government and TEPCO concerning the status of the nuclear power plants. Having obtained the result of emergency monitoring of environmental radioactivity, the prefectural government was aware that some regions had a high level of spatial dose rates of radiation. They also had confirmed that levels of radioactive iodine as high as over 1,000,000 Bp/kg were detected in grass collected on March 15 in places 35-45 km away from the nuclear power plant. When compared with the cities, towns, and villages that gave instructions on their own to distribute and take iodine tablets, it can be said that the Fukushima prefectural government possessed enough information on matters such as the level of spatial dose rates of radiation and the status of the nuclear reactors, to have decided whether iodine tablets should be taken or not.

The governor of Fukushima Prefecture, however, did not give instructions to take iodine tablets. In our 17th hearing, the governor described the reason. He said, "We carried out our operations after they had been confirmed by the central government" and "We as the prefectural government did not distribute [iodine tablets]." Regrettably, the response by the Fukushima prefectural government was indeed problematic.

[National Diet Report] Chapter 4, 4.4.2

The following isssues can be raised in association with the criteria for administration of stable iodide.

Radiological protection criteria – criteria for administration of stable iodide – confusion regarding administration criteria

- Local governments were able to obtain a sufficient amount of stable iodine tablets, but instructions to take the stable iodine tablets were not given because there was no information on predicted radiation dose by SPEEDI. On the other hand, new criteria for the administration of stable iodine were provided by the NSC on the basis of a screening level. This advice, however, did not reach Fukushima Prefecture and the cities, towns, and villages concerned. There was no opportunity to take iodine tablets except for some residents who were given instructions at a local government's own discretion.

  - On 13 March 2013, the NSC advised the ERC that stable iodine tablets should be provided to those who had radiation dose exceeding 10,000cpm detected at at their screening services. However, this information was not communicated to the local NERHQ.

  - At 01:25 on 16 March, the NSC distributed advice to the ERC to the effect that all of those remaining within a 20km radius should take stable iodine tablets while being evacuated.

  - The local NERHQ, which confirmed this advice via the ERC, issued a written order at 10:35 the same day to the leaders of the Fukushima prefectural government and 12 affected municipalities. However, the Fukushima prefectural government did not follow this instruction on the intake of stable iodine tablets because the government had already confirmed that there were no individuals remaining within a 20km radius.

  - The Fukushima prefectural government also asked the ERC and other organizations to help secure stable iodine tablets and was able to obtain approximately 1,360,000 stable iodine tablets from a major stable iodine manufacturer and from the Ibaraki prefectural government. On 14 March, the Fukushima prefectural government reached the decision to distribute two stable iodine tablets to each resident under 40 years of age in all municipalities within an approximate radius of 50km of the nuclear power station. However, the Fukushima prefectural government did not give instructions to each city, town, and village concerned to take iodine tablets, despite having the authority to do so.

  - During the night of 14 March, Miharu town officials had fears that its residents might be exposed to radiation and decided to distribute stable iodine tablets to its residents and instructed them to take the tablets. At 13:00 on 15 March, Miharu town officials, using a municipal disaster management radio communication network, made sure that each and every resident was informed of this decision. They distributed stable iodine tablets to approximately 95% of residents under the supervision of local pharmacists. Later, staff of the Fukushima prefectural government learned that the Miharu town office had distributed stable iodine tables and instructed the residents to take them. In the evening of the same day, the staff instructed Miharu town officials to stop distributing stable iodine tablets and to retrieve all of them as there had been no instructions from the national government. Miharu town officials did not obey this order.

・ Screening levels

Descriptions about screening levels are given in **[Governmental Interim Report]**, **[Governmental Final Report]**, **[Nongovenmental Report]** and **[TEPCO Report]** in the following way.

c. Implementation of screening

"What should be done in radiation emergency medical care and how" stipulates that relevant local governments, under mutual cooperation with their partner organizations, are specifying places where to conduct rescue and evacuation operations as well as planning to conduct screening services , if necessary. In response to this situation, the "Manual for radiation emergency medical care activities in Fukushima Prefecture" stipulates that a medical treatment team shall be established, which will be led by the divisional councilor of the hygiene services division of the department of health and welfare services in the Nuclear Emergency Response Center and that a screening team shall be established and will consist of health and welfare service staff, core-city healthcare center staff, doctors from the prefectural hospital and the medical association, and radiology technicians from the Fukushima Regional Association of Radiological Technologists, which will conduct body-surface contamination monitoring with survey meters to determine if monitored individuals or subjects need decontamination.

In response to the declaration of a nuclear emergency state by the Japanese government on the night of March 11, the Fukushima prefectural government decided to implement screening services and started doing so the next day, on March 12. However, there were far more monitoring subjects than expected so there were not enough staff members within the prefecture to allow them to adequately handle all screening services. The Fukushima prefectural government asked the national government, local governments, universities and the Federation of Electric Power Companies for their cooperation in conducting screening services at evacuation facilities and permanent facilities designed for community use. More than a total of 200,000 monitoring subjects representing over 10% of the prefectural population received screening services. The count rate of those monitoring subjects was between 13,000 and 100,000 cpm. The number of subjects who needed partial external cleansing was 901, and the number of subjects whose measured count rates was higher than 100,000cpm and needed whole body cleansing was 102. However, the count rates of those monitoring subjects whose measured exposure was higher than 100,000cpm was below the designated level when they removed their clothing.

[Governmental Interim Report] Chapter V 4

a. Screening level before the nuclear accident

The “Manual for radiation emergency medical care activities in Fukushima Prefecture,” which was created in 2004 fiscal year under the authority of the Fukushima prefectural government, was based on a manual entitled "Recommendation on radiation emergency medical care" which was prepared by the NSC in July 2001 and stipulated that the screening level for residents (a criterion of comprehensive outer body clean up) should be 40Bq/cm^2.

Since the level of 40Bq/cm2 is equivalent to counting rates of about 13,000cpm (counts per minute) when measured by survey meters owned by the Fukushima prefectural government, it set the screening level at 13,000cpm when the accident occured.

b. Raising the screening level after the nuclear accident

The Local NERHQ at the Off-site Center, which started discussions on screening levels on March 12, asked the ERC advice in the morning of March 13 on the Local NERHQ head’s draft instruction for setting the criterion of 40Bq/cm^2 or 6,000cpm.

At the ERC, the medical team was responsible for matters concerning the screening, but there was hardly anyone in that team, who had expertise on screening levels. Meanwhile, at the ERC, there were two liaison officials dispatched from the NSC. At around 10:13 on March 12, one of the

liaison officials faxed the draft instruction to the NSC to seek the NSC's opinion on the draft instruction. Upon receiving the fax, the NSC, at around 10:40 the same day, faxed a revised version of the above-mentioned draft instruction by adding comments that the screening level of 6,000cpm should be revised to 10,000cpm and that those who experienced exposure in excess of 10,000cpm should take stable iodine tablets, and the aforementioned liaison official received the fax. The said liaison official who received the comments from the NSC mentioned above told a staff member of the NSC Secretariat who called immediately afterwards that "Since we are already moving along this way, we can no longer change things about the screening level or the intake of stable iodine tablets". The Secretariat staff member told the NSC members of this conversation, but the NSC refrained from making any further advice on the grounds that the NSC is an advisory organization and that it has already advised on matters on which it should give advice.

No member of the ERC medical team received the revised comments of the NSC from the aforementioned NSC liaison official. Thus, the NSC's revised comments that recommended the intake of stable iodine tablets under certain conditions were not communicated to the ERC medical team, which inevitably did not consider them, and therefore did not convey them to the Local NERHQ.

As a result, at around 14:20 on March 13, the Local NERHQ, based on the provisions of Paragraph 3, Article 20 of the Nuclear Emergency Preparedness Act, handed to a prefectural government staff member an instruction document to the effect that the screening level should 40Bq/cm^2 or 6,000cpm, after making only some wording changes to the aforementioned draft instruction and without incorporating the NSC's comments on the intake of stable iodine tablets. However, as the prefectural government staff member who received this instruction did not deliver the instruction document to the rescue team that was responsible for matters related to the screening at the Prefecture Nuclear Emergency Response Center, and thus the instruction was not communicated to the rescue team.

The Fukushima prefectural government, meanwhile, already began the screening of evacuees from March 12, and was using the screening level of 40Bq/cm^2 prescribed in the "Manual for radiation emergency medical care activities in Fukushima Prefecture".

However, radiology experts in a radiation emergency medical care team dispatched to Fukushima Prefecture on March 13 came up with an opinion that the screening level should be raised from 40Bq/cm^2 (13,000cpm) to 100,000cpm, after considering that water (hot water) to be used for whole-body decontamination (showering) appears to be in short supply and that whole-body decontamination under low-temperature conditions is believed to have big disadvantages. Some of the aforementioned radiology experts disagreed to the raising of the screening level, but a majority of the radiation emergency medical care team ultimately supported the higher screening level. Based on the opinion of these experts, the Fukushima prefectural government decided to raise the screening level to 100,000cpm for whole-body decontamination from March 14 onward and also conduct wipe-off decontamination for those with the counting rate of 13,000cpm to less than 100,000cpm. At the time, as described, the instruction by the head of the Local NERHQ to set the screening level at 40Bq/cm^2 or 6,000cpm had not yet reached the rescue team of the Prefecture Nuclear Emergency Response Center. So, in deciding the new screening level, the Fukushima prefectural government did not discuss whether it would run counter to the instruction.

Around early in the evening of March 13, an ERC medical team staff member learned that the Fukushima prefectural government was going to raise the screening level to 100,000cpm by the communication from the prefectural government. But, since the staff member was not told by other team members that the aforementioned instruction by the head of the Local NERHQ had been issued and was not aware of the existence of that instruction, the staff member did not point out to the Fukushima prefectural government that its plan to raise the screening level to 100,000cpm would go against the aforementioned instruction.

Before dawn on March 14, having learned via the "ERC medical team status report" prepared by the ERC medical team that the Fukushima prefectural government was raising the screening level, the NSC held a discussion on the matter and concluded that if the entire 13,000cpm is from iodine from internal exposure, it would be equivalent to the infant thyroid equivalent of 100mSv,

which is the criterion of stable iodine administration90. Thus, at 4:30 the same day, the NSC provided the ERC with advice to the effect that "it is desirable not to raise the screening criterion to 100,000cpm and keep it at the current value of 13,000cpm." The ERC medical team staff member mentioned above received the NSC advice and relayed it to the Fukushima prefectural government. However, the Fukushima prefectural government decided to continue with the screening and decontamination with the new criterion, as it judged that the new screening level and decontamination methods it decided to apply from the same day would not go against the NSC advice because they involved partial wipe-off decontamination of those with the counting rate of 13,000cpm to less than 100,000cpm.

On March 18, four days after the NSC gave the advice that the screening level should be kept at 13,000cpm, the NSC received the request from the head of the Research Center for Radiation Emergency Medicine of the National Institute of Radiological Sciences (NIRS) that "it would be desirable to raise the screening level to 100,000cpm, as the air dose rate is high in the affected areas and the screening is difficult to conduct." Accepting the request, the NSC, at 14:40 on March 19, provided the ERC with the advice that the screening level should be raised to 100,000cpm ("Recommendation on screening criteria of radiation emergency medical care"). Acting on the advice, at 23:00 on March 20, the Local NERHQ issued an instruction to raise the screening level to 100,000cpm, based on the provisions of Paragraph 3, Article 20 of the Nuclear Emergency Preparedness Act. This means that no decontamination is required for those with the counting rates of less than 100,000cpm. However, the Fukushima prefectural government did not change its practice of conducting partial wipe-off decontamination for those with the counting rates of 13,000cpm to less than 100,000cpm, in order to ensure the safety of those with the counting rates of 13,000cpm to less than 100,000cpm and avoid confusing people at the screening sites by altering the criteria again.

[Governmental Final Report] Chapter IV 4

(d) Raising the screening level

To respond to the residents' concern regarding the fears of contamination by radioactive materials, appropriate screening and subsequent decontamination is absolutely necessary. Fukushima Prefecture initially established the screening level at 40 Bq/cm^2 (equivalent to 13,000 cpm), when it had started the screening process and subsequent decontamination on March 12, 2011. However, it raised on March 13, 2011 the screening level for whole-body decontamination to 100,000 cpm, effective from March 14, 2011, based on suggestions of radiological experts. But at this moment Fukushima Prefecture was not aware that the raised screening level was against the order from the Director-General of the Local NERHQ released in the afternoon of March 13, 2011 (the screening level to set at 40 Bq/cm2 etc.), because it had not been transmitted to the Prefectural Emergency Response Center.

One of the staff members of the ERC Medical Treatment Squad learned from a Fukushima Prefecture's report in the evening on March 13, 2011 that Fukushima Prefecture was intending to raise the screening level to 100,000 cpm. The staff member, however, did not know of the aforementioned order itself, and was not able to point out that raising the screening level to 100,000 cpm was against the said order. Knowing about the intentions of the Fukushima Prefecture government to raise the screening level before dawn of March 14 from an ERC report, the NSC reviewed the plan immediately and advised the ERC at 04:30 on the same day that the screening level should be kept at 13,000 cpm. This advice was conveyed to Fukushima Prefecture, but the prefecture kept its own policy and continued its own screening and decontamination procedures, based on the understanding that the new screening level and decontamination procedure did not necessarily contradict with the NSC's suggestion, because they decontaminated the people by partial sampling, instead of doing nothing to the persons counting not less than 13,000 cpm but below 100,000cpm.

Later at 14:40 on March 19, the NSC renewed its advice to the ERC and endorsed raising the level to 100,000 cpm, and on March 20, the Director-General of the Local NERHQ issued the order at 23:00 to set the screening level at 100,000 cpm. This new order, however, did not

stipulate to implement decontamination of the people counting not less than 13,000 cpm but below 100,000 cpm, leaving room to interpret as no requirement of decontamination of such people, and thus the new order became less strict than that of Fukushima Prefecture back then.

[Governmental Final Report] Chapter VI 1

Raising the screening level

In the first meeting of the Urgent Radiation Exposure Medical Care Adjustment Meeting held at 18:00 on 13 March, the following four points were discussed; 1) if 13,000 cpm derived in a normal situation is used as a radiological criterion, water for decontamination of a great number of evacuees could not be ensured because suspension of the water supply occurred in almost all areas, 2) shortage of human resouces, 3) low temperature that falls below the freezing point in the night, and 4) health risk when significant contamination remains by raising the screening level for decontamination. Finally, it was proposed to Fukushima prefecture to raise the screening level for whole-body decontamination to 100,000 cpm. On the next day, 14 March, the regional medical division of the Fukushima prefectural government decided that the screening level for whole-body decontamination was 100,000 cpm and partial wipe-off decontamination was necessary when the count rate was more than 13,000 cpm and also less than 100,000 cpm. Where is the legal foundation to change the screening level? Originally, there was no description to enable us to change the value of 13,000 cpm according to the emergency situation. However, this value was regarded as ineffective for the present accident, because this value was derived assuming a small amount of released radioactive iodine and was not an index considering the release of great deal of radioactive materials, a great number of evacuees, and the implementation of screening for them. According to the Act on Special Measures Concerning Nuclear Emergency Preparedness, the description on screening level is found in a section on emergency measures. In the nuclear emergency response section of the Fukushima Prefecture Regional Disaster Prevention Plan, the emergency measures have been prescribed as follows: “the government decides rapid emergency measures on the basis of technical suggestions of the Nucelar Safety Commission (NSC) and prepares to instruct them to prefectual or local governments”. On the other hand, one of the tasks of the Prefectural Headquarters for Disaster Control was “decision of the emergency measures”. Fukushima prefecture decided to raise the screening level on 14 March as part of the emergency measures. Receiving the decision, organizations associated with radiation survey implemented screening using the new value. At 4:30 on 14 March, the NSC advised the METI Emergency Response Center (NISA-ERC) regarding the screening level, and did not approve this change of the screening level at first. However, on 20 March, the NSC finally announced a notification to change the screeing level to 100,000 cpm.

[Nongovernmental Report] Part 2 Chapter 5 Section 6

(5) Exposure Dose Standards and Screening Guidelines in Times of Emergency

Meanwhile, after the accident at the Fukushima Daiichi NPS, when J Village and the Onahama Coal Center were being set up as entry and exit points to the contamination area, whereas there are guidelines for determining the need for decontamination, etc. (screening level), it was anticipated at the time that decontamination to the level stipulated by law ($4Bq/cm^2$) would be difficult. Therefore, the ERC Health Physics Team at the Headquarters asked emergency exposure medical experts, etc. visiting Fukushima Prefecture as an emergency medical team dispatched for the emergency for advice via TEPCO employees, to which the reply was received that a screening level of $40Bq/cm^2$ would be appropriate. In order to abide by this level for certain, the screening level was initially set conservatively at 6,000cpm. Thereafter, from the standpoint of keeping the screening levels consistent among related agencies, including Fukushima Prefecture, the screening level was set to 100,000cpm on and after April 20. This level of 100,000cpm was offered as advice on March 20 by the NSC in reference to an IAEA manual that stipulates screening levels for general residents. Furthermore, when the Nuclear Disaster Onsite Countermeasures Headquarters lowered the screening level from 100,000cpm to 13,000cpm, TEPCO was instructed to lower its screening levels in the same manner on and after September 16 and screening levels

were lowered to 13,000cpm.

[Tepco Report] Chapter 13 Section 2(5)

The following isssues can be raised in association with screening levels.

Radiological protection criteria –screening level – validity of the level

- The screening level was raised in accordance with the present situation using different levels from those that had been previously established.
  - The "Manual for Radiation Emergency Medical Care Activities in Fukushima Prefecture," which was created under the authority of the Fukushima prefectural government, was based on a manual entitled "Recommendation on Radiation Emergency Medical Care", which was prepared by the NSC, and stipulated that the screening level for residents (a criterion of comprehensive outer body clean up) should be 40Bq/cm^2. The Fukushima prefectural government set the screening level at count rates of 13,000cpm (counts per minute), which is equivalent to about 40Bq/cm^2 and started to implement screening services on 12 March 2011.
  - The Local NERHQ asked the ERC for advice in the morning of 13 March regarding setting the criterion of 40Bq/cm^2 or 6,000cpm. The ERC requested comments from the NSC on the criterion. The NSC responded that the screening level of 6,000cpm should be revised to 10,000cpm and that those who experienced exposure in excess of 10,000cpm should take stable iodine tablets; however, these comments were not communicated to the Local NERHQ by the ERC.
  - Radiology experts in a radiation emergency medical care team dispatched to Fukushima Prefecture on 13 March voiced the opinion that the screening level should be raised from 40Bq/cm^2 (13,000cpm) to 100,000cpm, after considering that water (hot water) to be used for whole-body decontamination (showering) appeared to be in short supply and that whole-body decontamination under low-temperature conditions is believed to have major disadvantages.
  - The Fukushima prefectural government decided to raise the screening level to 100,000cpm for whole-body decontamination from 14 March onward and also conducted partial wipe-off decontamination for those with a count rate of 13,000cpm to less than 100,000cpm.
  - Before dawn on March 14, having learned that the Fukushima prefectural government was raising the screening level, the NSC provided the ERC with advice to the effect that “it is desirable not to raise the screening criterion to 100,000cpm and to keep it at the current value of 13,000cpm.” However, the Fukushima prefectural government decided to continue with the screening and decontamination with a screening criterion of 100,000cpm, as it judged that the new screening level and decontamination methods would not go against the NSC advice because they involved partial wipe-off decontamination of those with a count rate of 13,000cpm to less than 100,000cpm.

・ Subsequently, the NSC received the request that “it would be desirable to raise the screening level to 100,000cpm, as the air dose rate is high in the affected areas and screening is difficult to conduct.” Accepting the request, the NSC, at 14:40 on 19 March, provided the ERC with the advice that the screening level should be raised to 100,000cpm (“Recommendation on Screening Criteria of Radiation Emergency Medical Care”).

・ Criteria for contamination of soil, etc.

Descriptions about criteria for contamination of soil (schoolyards and educational facilities, and bathing areas, utilization of crushed stones, and disposal of disaster waste and sewage sludge) are given in **[Governmental Interim Report]**, **[Governmental Final Report]**, **[National Diet Report]** and **[Nongovenmental Report]** in the following way.

a. Schoolyards and the other educational facilities in Fukushima Prefecture

Fukushima Prefecture requested the Local NERHQ to indicate the criteria for reopening the schools and the other educational facilities in the prefecture. In response to the request, MEXT began to consider the criteria. From April 6 to 7, MEXT requested the Nuclear Safety Commission to deliberate on the criteria for reopening by presenting the results of the air radiation dose rate measurements that Fukushima Prefecture took in the schoolyards of elementary and junior high schools, preschools and nursery schools within the prefecture (except those in the evacuation area within a 20km radius of the Fukushima Dai-ichi NPS). However, the Commission, as an advisory agent, replied to the Ministry that some planned criteria should be proposed first. On April 8, MEXT was directed by the Prime Minister's Office to deliberate on the criteria for the use of school facilities as a matter of the whole Government. Therefore MEXT began consulting on the criteria of use with the Nuclear Safety Commission.

At the time, MEXT believed that it was necessary to consider the consistency of the criteria for the establishment of the planned evacuation area, which was deliberated within the Government, and the contribution of internal exposure. On April 11, the NERHQ specified the area where the cumulative radiation dose may exceed 20mSv as the planned evacuation area based on the criteria of 20-100mSv that had been established by the ICPR in the event of an emergency when evacuation is required (a reference level for public exposure in the event of an "radiation emergency situation" in the recommendation issued in 2007). MEXT decided 20mSv/year, which is the upper limit established by the ICPR for a situation after an accident has stabilized (a reference level for public exposure in the event of an "exiting exposure situation" in the recommendation issued in 2007) as the criterion. Further, MEXT estimated that the contribution of the internal radiation dose to the whole radiation dose is 0 to 5.6% (2.2% on average). Because this contribution was small, the Ministry decided not to take the effect of internal exposure into consideration and to calculate the total exposure as external exposure. Assuming a student stays indoors for 16 hours and outdoors (in schoolyard) for eight hours a day, an air radiation dose rate of 3.8μSv/h corresponds to 20mSv/year of exposure. Therefore MEXT decided to adopt this value as a guide. Furthermore, the Ministry considered that "it is appropriate to decrease the dose rate that students are exposed to as much as possible while adopting the criterion of 1 - 20mSv/year as the reference level after an emergency situation has stabilized as a tentative guideline," and "even if an air radiation dose rate exceeding 3.8μSv/hour is measured, the level that students are exposed to can be limited to 20mSv/year by taking countermeasures to ensure activities are mainly done indoors." Based on this consideration, MEXT established the "Provisional view regarding the judgment of the use of schoolyards and educational facilities in Fukushima Prefecture" indicating

that: (1) activities in the schoolyard should be restricted to approximately one hour a day when an air radiation dose rate exceeding 3.8μSv/h is detected in the schoolyard, and (2) the schoolyard can be used as usual when an air radiation dose rate below 3.8μSv/h is detected. MEXT submitted this provisional view to the NSC via the NERHQ and asked for its advice on April 19. This view meant that no upper limit was established on the air radiation dose rate for schoolyards that can be used as per (1) above, and the schoolyard can be used without any limitation when the air radiation dose rate is less than 3.8μSv/h as per (2).

Considering that it is required to reduce the radiation dose of students as much as possible, the NSC Japan admitted in its response to the request from MEXT that the view of the NERHQ was to minimize the radiation doses of students, on condition that: (1) the results of measurements such as the consecutive monitoring should be reported to the Committee approximately once every two weeks, and (2) approximately one pocket dosimeter should be distributed to each school and provided to a faculty staff member who represents the activity pattern of the students to check the exposure condition.

On the same day, after receiving this response, MEXT notified Fukushima Prefecture of the abovementioned "Provisional view regarding the judgment of the use of schoolyards and educational facilities in Fukushima Prefecture" with the condition indicated in the NSC 's advice.

On May 11, MEXT suggested two measures for the surface soil in the schoolyard, "to intensively gather and store underground" and the "upside-down replacement method," as effective exposure reduction methods based on the result of the investigation conducted by JAEA. On May 27, the Ministry decided to provide financial support to the owners of educational facilities that implemented the exposure reduction method for the soil in their schoolyards in schools where air radiation dose rates exceeding 1μSv/h were detected.

On August 26, MEXT indicated the level that students would be exposed to should be 1mSv/year or less in schools after the summer vacation ended and the air radiation level rate of 1μSv/h or less as the guide to meeting the criterion. The Ministry also suggested that, although it is not required to restrict outdoor activities even if the air radiation dose rate exceeded the guide, it was preferable that measures such as decontamination were taken promptly, and it was important to identify and decontaminate the area where high radiation doses were detected locally.

Additionally, after April 14, MEXT consecutively monitored the schoolyards of 52 schools where relatively high air radiation dose rates (3.7μSv/h or higher) had been detected during the monitoring performed by Fukushima Prefecture from April 5 to 7. As a result, air radiation dose rates of 3.8μSv/h or higher were detected in 13 facilities on April 14, however, an air radiation dose rates of 3.8μSv/h or higher was not detected in any school after May 12. The highest level on August 25 was 0.8μSv/h.

b. Criteria for disaster waste disposal

An extremely large amount of disaster waste was produced by the earthquake and tsunami. The Waste Management and Public Cleansing Act does not apply to waste that is contaminated with radioactive materials (Article 2 Clause 1 of the Act) and there is no other law that regulates the disposal of disaster waste contaminated with radioactive materials. Therefore the Ministry of the Environment established the criteria for disposal in consultation with the Ministry of Health, Labour and Welfare and METI.

On May 2, the Ministry of the Environment decided in consultation with the related ministries and agencies to conduct an investigation into the concentration of radioactive materials in the disaster waste in the Hamadori and Nakadori regions of Fukushima Prefecture, then continued further studies based on the results of this investigation and presented the "Disposal Guideline for Disaster Waste in Fukushima Prefecture" on June 23. In this guideline, the Ministry indicated several criteria such as: the incinerated ash of the disaster waste may be disposed in landfill when the concentration of radioactive cesium is 8,000Bq/kg or less; when the concentration is between 8,000Bq/kg and 100,000Bq/kg, preferably the ash should be stored temporarily until the safety of disposal is confirmed; and preferably the ash should be stored within a facility that is capable of shielding radiation when the concentration exceeds 100,000Bq/kg.

Because radioactive materials of high concentration were detected in the incinerated ash of the

waste even in prefectures other than Fukushima, the Ministry of the Environment presented the "Present Guideline for Measurement and Handling of Incinerated Ash in General Waste Incineration Facilities" as a standard for the handling of the incinerated ash according to the disposal policy for the disaster waste in Fukushima Prefecture to 16 prefectures in the Tohoku, Kanto and other districts on June 28.

On August 31, the Ministry of the Environment indicated a policy that permitted the disposal of incinerated ash with a concentration of radioactive cesium in the range of 8,000Bq/kg to 100,000Bq/kg in landfill, which had been previously been considered preferable to be stored temporarily until the safety of its disposal was confirmed, on condition that: (1) public water areas and groundwater should be protected from contamination by radioactive cesium, and (2) the landfill sites should be placed under long-term control including restrictions on the use of the site.

c. Sewage sludge

On April 30, a high concentration of radioactive cesium was detected in sewage sludge in Fukushima Prefecture. After this was reported, inspections for radioactive materials in sewage sludge were conducted in other prefectures and similarly high concentrations were detected.

There are two types of sewage treatment: (1) combined sewerage (which collects the sewage and rainwater in the same sewage pipe for transfer to a sewage treatment plant), and (2) separate sewerage (which collects the sewage and rainwater in separate pipes that transfer only the sewage to a sewage treatment plant and let the rainwater flow into a river and/or the ocean). The high concentrations were detected in the sludge in the sewage treatment plants of the combined sewerage system. Therefore it is believed that the high concentrations of radioactive materials were detected because of the dispersed radioactive materials which were carried by the rainwater to the sewage treatment plants and concentrated there.

On May 12, the NERHQ presented "Concept of Provisional Handling of Sewage By-products in Fukushima Prefecture" to indicate that the dehydrated sludge with a relatively high concentration exceeding 100,000Bq/kg should be stored appropriately after volume reduction in the prefecture whenever possible.

On June 16, at the request of other prefectures to indicate a criterion for the dehydrated sludge, the NERHQ presented "Provisional View on By-products of Sewage Treatment and the like in which a High Concentration of Radioactive Materials is Detected" to indicate that: the sludge in which radioactive cesium over 100,000Bq/kg has been detected preferably should, where possible, be stored in a facility that is capable of shielding radiation within the prefecture from where the sludge originated; sludge with radioactive cesium of 8,000Bq/kg or less may be disposed of in landfill on certain conditions, such the landfill site not be used for residential purposes; and sludge with radioactive cesium in the range of 8,000Bq/kg to 100,000Bq/kg may be disposed of in landfill under certain control conditions.

d. Disposal site for sewage sludge and the like

The Nuclear Emergency Response Center and the Ministry of the Environment indicated the disposal criteria for dehydrated sludge and incinerated ash containing radioactive materials. However, their disposal and reuse have not progressed because of opposition from the inhabitants around the disposal sites and rejection from the disposal operators, therefore some sewage treatment plants and waste incineration facilities are still being forced to store the sewage sludge and incinerated ash that has not been accepted.

(3) Contamination of seawater, pool water, etc.

a. Criteria for bathing areas

On June 7, the Ministry of the Environment began to deliberate on guideline regarding the use of bathing areas in response to the directive from Chief Cabinet Secretary Edano. On June 14, the Ministry held the Roundtable Conference for Radioactive Materials in Bathing Areas to hear from experts on radioactive materials. On June 24, on the basis of advice from the NSC Japan, the Ministry presented a guideline about radioactive materials in bathing areas that indicated: (1) radioactive cesium of 50Bq/liter or less and radioactive iodine of 30Bq/liter or less should be

considered as the provisional guideline for the summer of 2011; (2) managers of bathing areas preferably should monitor the concentration of radioactive materials in the water and display the result on a placard or some other means; (3) managers and users of bathing areas preferably should take measures to reduce the effective radiation dose; and (4) managers of bathing areas preferably should monitor the air radiation dose rate at the beach and the like and caution users displaying the result on a placard or some other means when an air radiation dose rate higher than the surrounding area is detected.

b. Use of outdoor swimming pools in schools in Fukushima Prefecture

On June, MEXT decided not to indicate any guidelines for assessing the use of outdoor swimming pools because radioactive iodine, cesium and other radioactive materials had not been detected in the tap water of Fukushima Prefecture and it was thought students would only be exposed to very low levels of radiation from the water in swimming pools. When using outdoor swimming pools, the levels of radiation that students will be exposed to should be estimated by monitoring the water in the pool.

[Governmental Interim Report] Chapter V 5

a. Schoolyards and the other educational facilities in Fukushima Prefecture

The circumstances that led the MEXT to present the "Provisional criteria regarding the judgment of the use of schoolyards and educational facilities in Fukushima Prefecture" (hereinafter referred to as the "Provisional criteria") on the use of school building and schoolyards at schools in Fukushima Prefecture were as described in Chapter V 5. (2) a. of the Interim Report.

In the Provisional criteria presented on April 19, the concept was that if the air radiation dose rate in schoolyards is 3.8 μSv/h or below, the radiation exposure would not exceed 20 mSv/year, the upper limit of the reference level for public exposure in an "existing exposure situation" established by the ICPR (see Chapter V 4. (1) b. of the Interim Report), assuming that if a student stays outdoors (in the school yard with the air radiation dose rate of 3.8 μSv/h) for eight hours a day and in wooden buildings (the air radiation dose rate of 3.8 μSv/h×0.4) for 16 hours a day, the annual exposure dose would be 20mSv. On May 12, the MEXT announced the results of the calculations of the accumulated dose in a one-year period after the nuclear accident estimated on the basis of life patterns of students. In the calculations, the behavioral patterns of students were assumed by closer-to-reality values, and the air radiation dose rates used were those in concrete buildings where students actually spend school hours. All in all, the assumptions used in the calculations were much closer to the reality than those that supported the Provisional criteria.

More specifically, the calculations were based on the following assumptions: (i) the accumulated radiation dose between the nuclear accident and April 14 is 2.56 mSv, (ii) using the assumed air dose rate of 3.8 μSv/h in schoolyards as the reference level, the air dose rate in school buildings is set at 0.1 times, the air dose rate outdoors outside school at 0.61 times, the air dose rate in wooden houses at 0.244 times, (iii) in the life patterns of school days (200 days) between April 15, 2011, and March 11, 2012, students spend one hour in commuting to school, two hours in school yards, five hours in school buildings, three hours outdoors outside of school, and 13 hours in wooden houses, (iv) in the life patterns of holidays (131 days) between April 15, 2011, and March 11, 2012, students spend eight hours outdoors and 16 hours in wooden houses, (v) the average attenuation rate of the air dose rate between April 15, 2011, and March 11, 2012 is 0.705. Based on the above assumptions, the cumulative radiation dose for students in a one-year period after the nuclear accident was estimated at 9.99 mSv.

In the Provisional criteria, the MEXT explicitly stated that it adopted the criterion of 1-20mSv (the reference levels for public exposure established by the ICRP for an "existing exposure situation" after an accident has stabilized in its 2007 recommendation (Pub.103)) as a "tentative guideline." However, MEXT Minister Yoshiaki Takagi (hereinafter referred to as "MEXT Minister Takagi") referred to matters not contained in the Provisional criteria several times in his replies to interpellations in the Diet, saying that "with the severest value of 20mSv/year in the reference levels of 20-100mSv/year in the event of a radiation emergency situation as the starting

point and with the reference levels of 1-20mSv/year after an emergency has stabilized as a tentative guideline, we have adopted the policy that is appropriate to decrease the exposure dose as much as possible." MEXT officials in charge of relevant matters prepared draft replies in light of MEXT Minister Takagi's way of thinking and intentions. The MEXT Minister and others referred to "with the severest value of 20mSv/year in the reference levels of 20-100mSv/year as the starting point" in an effort to mitigate anxieties among residents in Fukushima Prefecture as much as possible.

(Omission)

e. Handling of contaminated crushed stones

On December 28, the Fukushima Decontamination Team of Ministry of Environment (hereinafter referred to as the "Decontamination Team") received a request from the Nihonmatsu municipal government: "A junior high school student residing in Nihonmatsu City showed the cumulative radiation dose of 1.6mSv over a three-month period. When we looked into the matter, the air dose rate in the condominium the student lives in was higher than the outdoor air dose rate. We would like the Decontamination Team to investigate the cause of this." Upon receiving the request, the Decontamination Team, in cooperation with the Nihonmatsu municipal government, checked on the condominium and also had interviews with officials of the constructor of the condominium on January 5-6, 2012. As a result of its investigation, the Decontamination Team concluded that it is highly likely that the crushed stones shipped from a quarry in Namie Town were contaminated and were used in constructing the condominium. On January 6, the Decontamination Team, through the Local NERHQ and others, communicated with the METI, which has jurisdiction over civil engineering and building materials, to that effect.

Upon receiving the communication, the METI identified the quarry that shipped crushed stones used in the building of the condominium (it is located in the deliberate evacuation area about 25km in a straight line distance from the Fukushima Dai-ichi NPS; hereinafter referred to as "Quarry A"), and found after the further investigations in cooperation with the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and the relevant municipalities that: (i) Quarry A was shipping out crushed stones between the nuclear accident and April 22, when the area in which it is located was designated as the deliberate evacuation area, (ii) the air dose rate within Quarry A was high relative to the air dose rates in neighboring quarries; (iii) the air dose rate at another construction site where crush stones shipped by Quarry A were used (an agricultural waterway built by the constructor that constructed the condominium on the same day as the date of commencement of construction work on the condominium) was higher than the air dose rate in the surrounding areas, and (iv) no other construction sites that used crushed stones from quarries other than Quarry A showed higher air dose rates than those in the surrounding areas.

Upon receiving the request for the establishment of criteria for radioactive materials in crushed stones, etc. around mid-January 2012, the METI considered the matter and, on March 22, 2012, presented the "Shipment Criteria for Crushed Stones and Gravel" intended for the Coastal (Hama-dori) and Central (Naka-dori) regions in Fukushima Prefecture, which allows shipments of these products with the radioactive cesium concentration of no higher than 100Bq/kg (for crushed stones and gravel used in public works projects outdoors, the surface dose rate of no higher than 0.23 μSv/h).

In May 2011, before the distribution of contaminated crushed stones was discovered, the Director-General of the Public Works Department of the Fukushima prefectural government asked the Local NERHQ to present the criteria for radiation doses of materials used in public works projects. The request was conveyed by the Local NERHQ to the Nuclear Sufferers Life Support Team. The Team considered on how to reply to the request, but the official reply to the request is yet to come. The shipment of contaminated crushed stones from Quarry A was made before the designation of the deliberate evacuation area on April 22, 2011, or before the request of the Director-General of the Public Works Department came.

[Governmental Final Report] Chapter IV 5

4.4.4 Resumption of schools

1. Debate shifts from whether schools should be resumed to whether use of school grounds needs to be restricted

In late March 2011, spring vacation began for kindergartens, elementary schools, junior high schools, and special-needs schools, as well as for the nursery centers in Fukushima Prefecture. Fukushima Prefecture deliberated whether or not the new term for schools and nursery centers should commence in April as scheduled.

Following the accident, a decision was made at the Prime Minister's Nuclear Emergency Response Headquarters that MEXT would take charge of establishing the benchmark regarding the school resumption issue. On April 6, 2011, MEXT submitted to NSC the air dose monitoring results for the school grounds of elementary and other schools should be resumed. The same day, MEXT again requested NSC's advice on specifying the "areas where the air dose rate is not low." The next day, on April 7, NSC suggested that MEXT present its own benchmark for judgment, and as reference, advised them that the exposure dose limit for the public was 1mSv/year. The same day, despite the advice from NSC, MEXT again requested NSC for advice on whether schools should be resumed. NSC's response to MEXT was the same was as stated in its previous response.

On April 9, MEXT shifted the topic of consideration from whether schools should be resumed to the setting of a numerical benchmark for judging whether school buildings and grounds, etc. could be used, assuming the schools would resumed. Based on the fact that the upper boundary for the reference level on the dose that the general public would allow after the accident settles as set forth in the 2007 recommendations of ICRP, MEXT proposed to NSC that the exposure dose be set at 20mSv/year as an approximate benchmark. The same day, NSC responded that: (i) The 20mSv/ year benchmark, which is the upper boundary for the reference level in the ICRP 2007 recommendations, should be utilized on a limited basis; and (ii) Even if this value is adopted, the doses for external and internal exposures combined should fall within the benchmark. NSC advice was to the effect that, in order to set forth a maximum permissible limit for external exposure only, the contribution of internal exposure should be estimated at around the same dose as external exposure, and therefore, a benchmark should be decided by roughly halving the upper boundary. Furthermore, at a press conference on April 13, NSC members stated that in view of internal exposure, an exposure dose of around 10mSv per year is acceptable.

Nevertheless, MEXT calculated that the contribution of internal exposure was negligible enough to ignore. On this basis, through its exchanges with NSC, MEXT set on April 19 the provisional exposure dose value for judging the use of school buildings and grounds, etc. at 1-20mSv/year, and by extension, stuck with the 20mSv/year value. In accordance with this, MEXT decided to restrict the outdoor activities of children and students only at the schools which have school and kindergarten grounds with air dose measurements of more than 3.8μSv/h – equivalent to an exposure dose of 20mSv per year. Regarding schools with less than 3.8μSv/h, MEXT and NSC concluded that it was acceptable to utilize school buildings and grounds, etc. normally, and NERHQ made an announcement to this effect. MEXT issued a notification about this to the Fukushima Prefectural Board of Education. As a result, limitations on the use of school grounds and on outdoor activities were imposed on 13 schools with air doses exceeding 3.8μSv/h (as of April 19). These included restrictions of outdoor activities to less than one in Fukushima Prefecture, and requested NSC's advice on the safety of resuming schools and on whether the resumption of such schools was advisable. On the same day, NSC responded: (i) Even if schools in the Indoor Evacuation Area within the 20-30km radius zone of the Fukushima Daiichi Nuclear Power Plant were to be resumed, it would be undesirable for children and students to play outdoors; and (ii) For all other areas where the air dose rate was not low, due consideration should be given to whether schools should be resumed. The same day, MEXT again requested NSC's advice on specifying

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MEXT's shift in the topic of consideration coincided with the beginning of the new term for the schools and nursery centers in Fukushima Prefecture, generally April 6 and 7, 2011.

Furthermore, MEXT, in setting forth a benchmark for judging the use of school buildings and grounds, confirmed, as of its exchanges with NSC on April 12, the number of schools and nursery centers upon which the restrictions would be imposed. If an air dose of 3.8μSv per hour and half this value of 1.9μSv/h were to be adopted as the benchmark for judgment, the number of schools in Fukushima Prefecture to which the restrictions apply, was 43 and 414 schools, respectively (as of April 8).

MEXT shifted the topic of consideration and fixated on 20mSv per year to confirm the status quo and to implement minimum restrictions on outdoor activities. Doubts remain about the extent to which MEXT considered the health and safety of children.

2. Meaning of the benchmark

The 3.8μSv per hour air dose, which MEXT set forth as the benchmark on the basis of which to impose restrictions on the use of school grounds, was calculated by taking the ICRP 2007 recommendations' upper boundary of the reference level (1-20mSv per year) on the dose that the general public should receive after an emergency settles. However, this value was equivalent to the 20mSv per year dose assumed in the government's establishment of the Deliberate Evacuation Area at around the same time on April 22. Consequently, the Japanese public strongly protested that 3.8μSv per hour was too high, on the grounds that the benchmark for ensuring the safety of children was set at the same dose level as for areas requiring evacuation.

Incidentally, in Ukraine five years after the Chernobyl nuclear accident, residents were forbidden to live in areas that had a projected dose of more than 5.0mSv per year. MEXT's dose benchmark for imposing school ground use restrictions was even higher than the dose benchmark that was applied in Ukraine.

3. Exposure reduction measures

After MEXT notified Fukushima Prefecture of the benchmark for judging the use of school buildings and grounds, etc., the Japan Federation of Bar Associations and the Japan Medical Association issued statements urging that the restrictions on the use of school grounds be dealt with carefully. In addition, MEXT Minister Yoshiaki Takaki received a request dated May 23 from 70 parents and guardians in Fukushima Prefecture asking the government to retract the 20mSv/year benchmark for the use of school grounds.

In response, on May 27, MEXT issued a notification to Fukushima Prefecture, entitled, "Near-Term Measures for Reducing the Dose Affecting Children and Students, Etc. Receive at Schools and Other Facilities in Fukushima Prefecture." While maintaining the aforementioned benchmark of 1-20mSv per year, MEXT aimed to keep the dose that children and students, etc. receive at schools in FY2011 to 1mSv/ year in the near term. Furthermore, MEXT decided to distribute dosimeters to all schools and nursery centers in Fukushima Prefecture as well as offer financial support for schools at which the air dose rate of the school grounds and other areas measured more than 1μSv/h, in order to help cover the costs of decontamination.

Until then, MEXT's only exposure reduction measure for Fukushima Prefecture was to have school personnel wear dosimeters to confirm the status of exposure. For schools with air dose measurements under 3.8μSv/h, MEXT had no rational and viable exposure reduction measures in place, such as restrictions on the use of school grounds and postponement of school start dates. Assuming that radiation exposure should be kept as low as is rationally feasible in line with the views of ICRP, we believe that MEXT's position to not consider any exposure reduction measures for schools with air doses not exceeding the benchmark was problematic.

[National Diet Report] Chapter 4, 4.4.4

Section 3 Environmental Restoration and Waste Management

Protection of children

Concern regarding the effects of radiation on children has become a particularly significant issue. According to the ICRP, on 19 April, MEXT issued provisional criteria on the use of school buildings and schoolyards at schools in Fukushima Prefecture to restrict the outdoor activities of children and students to less than one hour per day only at the schools that have air dose measurements of more than 3.8μSv/h. According to the measurement results obtained by MEXT on 14 April, 52 kindergardens and 13 primary or junior high schools fell under this restriction.

In the notification on 26 August, MEXT indicated the level that students would be exposed to should be 1mSv/year or less in schools and the ambient dose rate of 1μSv/h or less as the guide to meeting the criterion, referring to the reference levels (1 to 20 mSv/y) after the emergency situation given by the ICRP recommendation.

[Nongovernmental Report] Part 1 Chapter 2 Section 3

The following isssues can be raised in association with criteria for contamination of soils (schoolyards and educational facilities, and bathing areas, utilization of crushed stones, and disposal of disaster waste and sewage sludge).

Radiological protection criteria – criteria for contamination of soil (schoolyards and educational facilities, and bathing areas, utilization of crushed stones, and disposal of disaster waste and sewage sludge) – consistency of concepts for derivation of criteria

- It has become difficult to explain the consistency among all the criteria since each criterion was determined using a different concept.
  - The value of 3.8μSv/h for ambient dose rate, which was announced by MEXT in "Provisional view regarding the judgment of the use of schoolyards and educational facilities in Fukushima Prefecture" was derived using 20mSv/y, which is the upper limit in the band of reference level established by the International Commission on Radiological Protection (ICRP) for an existing exposure situation. Subsequently, MEXT decided to aim to reduce the level of contamination to 1mSv/y.
  - The provisional criterion for bathing areas announced by the Ministry of the Environment (MOE) was derived such that the individual dose due to external and internal exposure would be within 10% of 1mSv/y.
  - The concept of the reference level established by the ICRP for an existing exposure situation was not applied to the criteria of utilization of crushed stones and disposal of disaster waste and sewage sludge. These criteria were derived from “Near-term policy to ensure the safety for treating and disposing of contaminated waste around the site of Fukushima Dai-ichi Nuclear Power Station of Tokyo Electric Power Company” (control not to exceed 1mSv/y for residents and workers and 10μSv/y for the public in the case of recycling exposure scenario) announced by the NSC on 3 June 2011.

- Criteria for food and beverages

Descriptions about criteria for food and beverages are given in **[Governmental Interim Report]**, **[Governmental Final Report]**, **[National Diet Report]** and **[Nongovenmental Report]** in the following way. Estimation results of dose due to intake of food and beverages are described in [**MHLW HP (30 Oct. 2011)**] and [**MHLW HP (11 Mar. 2013)**].

c. Provisional regulation value for food and beverages

The MHLW, which is in charge of the Food Sanitation Act, had never examined the adequacy of existing criteria for strategies on what to do with food and beverages distributed within Japan if they were contaminated with radioactive materials.

On March 15, as described above, a high concentration of radioactive materials was detected in weeds that had been collected in Fukushima Prefecture. The MHLW staff in charge of this matter thought some action should be taken with regard to the radioactive contamination of food. They determined, however, that any action should be consistent with the Act on Special Measures Concerning Nuclear Emergency Preparedness. In other words, they did not imagine that any action could be taken on the basis of the Food Sanitation Act. Meanwhile, MAFF was worried that agricultural products might be seriously impacted by rumors. Hence, they determined that in

order to prevent agricultural products from being negatively affected by rumors, it was necessary to develop general criteria for deciding whether or not any food in question should be allowed to be distributed within disaster-affected regions as well as to non-affected regions. On March 16, MAFF strongly urged the MHLW to implement criteria for food exposed to radioactive materials in accordance with the Food Sanitation Act. In addition to this urgent request from MAFF, the MHLW itself determined that it was necessary to examine food distributed in a wide range of areas on the basis of the Food Sanitation Act and decided to examine the adequacy of criteria for radioactive material as prescribed in the Act. Finally, the MHLW decided that the index for restrictions on the intake of food and beverages, which the NSC had implemented based on the simulation of a nuclear accident within Japan, should be adopted in order to take swift and appropriate action and solve the current emergency situation. The MHLW decided to adopt the Index as the provisional regulation value for food and beverages in accordance with the Food Sanitation Act. The MHLW naturally took into consideration the significant potential effects of radioactive iodine on childhood thyroid cancer and adopted the Codex Index (100Bq/kg as the criterion for all food and beverages in terms of radioactive iodine). The MHLW also decided that milk and dairy products exceeding the criterion of 100Bq/kg should not be used for modified dry milk for infant or for milk to be directly consumed. Additionally, on March 17, the MHLW issued a notice to all prefectural governments to the effect that the index value indicated by the NSC should be adopted as a temporary provisional regulation value (hereinafter referred to as "provisional regulation values") and that any food or beverages exceeding this criteria should not be provided for human consumption pursuant to Paragraph 2 of Article 6 of the Food Sanitation Act.

In terms of the Basic Food Safety Act, the MHLW did not have to ask the Food Safety Commission for advice (hereinafter referred to as "Advice") on the effects of the implemented provisional regulation values on food security and health. However, the MHLW decided that it was proper to ask for arbitrary advice in accordance with Paragraph 3 of Article 24 of the same Act. On the other hand, Article 11 of the Act stipulates that in a situation where the MHLW must ask the Food Safety Commission for advice, the MHLW does not have to comply in the event of an exceptionally urgent case. The MHLW implemented the provisional regulation values after deciding that they had to take urgent action on food and beverages contaminated with radioactive materials.

Additionally, on March 20, the MHLW minister asked the Food Safety Commission for advice on the index value (provisional regulation value) for radioactive material in food and beverages. On October 27 of the same year, the Food Safety Commission issued a notice addressed to the MHLW minister on the effects of the implemented provisional regulation value on food security and health in which no evaluation results per radionuclide were provided.

d. Provisional regulation value for seafood

On April 4 of the same year, 4,080Bq/kg of iodine 131 was detected in young sand eels that were caught off the coast of Ibaraki Prefecture on April 1. Detailed data was sent to the MHLW.

As described above, the NSC Indices for restricting the intake of food and beverages contain no criteria for the restriction of seafood contaminated with radioactive iodine nor do the provisional regulation values based on the Indices for restricting the intake of food and beverages. Hence, the MHLW decided that it was necessary to implement temporary regulation values for seafood in terms of radioactive iodine and thus began an urgent discussion with the NSC. As a result of the discussion, the MHLW decided to adopt 2,000Bq/kg as a criterion value for seafood in terms of radioactive iodine, with the understanding that a criterion value of 300Bq/kg for drinking water, milk and dairy products, and a criterion value of 2,000Bq/kg for vegetables in terms of radioactive iodine were already implemented as regulation values and could be used as references, and because both seafood and vegetables were classified as solid food. On April 5, on the basis of the advice of the NSC, the MHLW issued a notice to all local governments to the effect that provisional regulation values for seafood in terms of radioactive iodine should be 2,000Bq/kg and that any seafood exceeding this criterion should not be provided for human consumption pursuant to Paragraph 2 of Article 6 of the Food Sanitation Act.

e. Provisional regulation values for tea

Tea was classified as "other" in the Index for restricting the intake of food and beverages. The provisional regulation value for tea was 500Bq/kg. On May 11 of the same year, radioactive cesium exceeding the provisional regulation value of 500Bq/kg was detected in green tea leaves produced in Kanagawa Prefecture. In response to this, the MHLW asked fourteen local governments to perform more intensive monitoring of green tea leaves. Additionally, on May 13, radioactive cesium exceeding the provisional regulation value was detected in unrefined (dried) tea leaves produced in Kanagawa Prefecture. In response to this, on May 16, the MHLW asked fourteen local governments to perform monitoring of unrefined tea leaves to restrict the distribution of unrefined tea leaves that exceeded the provisional regulation value (500Bq/kg).

Because unrefined tea leaves were monitored with the same criteria as green leaves, there was a consensus among the relevant local governments and within the national government that monitoring unrefined tea leaves according to the same criteria as green leaves did not fit reality based on the following reasoning: unrefined tea leaves may have a concentration of radioactive cesium five times greater than that of green leaves because they are dry-processed; and tea, which is nearly always for drinking, is prepared by steeping tea leaves in hot water reducing concentration levels. However, on June 2 of the same year, the MHLW issued a notice to the effect that the same temporary regulation value should be applied to all types of tea leaves including unrefined tea leaves on a regular basis. Relevant industry groups, worried that tea products might be negatively affected by rumors, strongly recommended the monitoring of tea leaves. Ultimately, all local governments decided to perform monitoring of unrefined tea leaves.

[Governmental Interim Report] Chapter V 5

j. New regulation values for food

As described in Chapter V 5. (1) c. of the Interim Report, the MHLW set the provisional regulation values for radioactive materials in food on March 17, after the occurrence of the nuclear accident, and on March 20, asked the Food Safety Commission for recommendations on regulation values (index values) of radioactive materials (request for the Assessment of the Effect of Food on Health), receiving the notification of the results of the assessment on October 27. The MHLW decided to consider new regulation values with the basic concept of lowering the maximum permissible dose to 1mSv a year, while paying heed to the assessment of the effect of food on health. On October 28, the MHLW asked the Pharmaceutical and Food Sanitation Council for its recommendations on standards and criteria concerning radioactive materials in food, based on Article 11, Paragraph 1 of the Food Sanitation Act.

On December 22, the Radioactive Material Measures Working Group of the Food Sanitation Subcommittee of the Council judged that the lowering of the regulation value (the intervention dose level) to 1 mSv per year is appropriate, and recommended that given that new standard limits replacing the provisional regulation value are designed to the long-term situation going forward in the wake of the accident at the Fukushima Dai-ichi NPS, only radionuclides for which the long-term effects need to be considered (radionuclides with long half-lives) should be subjected to the regulations. The Working Group then presented a draft for new standard limits, changing the classification of foods from the five categories for the provisional regulation values to the four categories of “drinking water,” “infant foods,” “milk” and “general foods” for the new standard limits.

Subsequently, on January 17, 2012, the MHLW once again asked the Food Safety Commission for its opinions about the establishment of standards and criteria for radioactive materials in food. On January 19, the Food Safety Commission told the MHLW that another Assessment of the Effect of Food on Health is unnecessary, saying that “the Commission notified the results of the Assessment in the Cabinet Order No. 862 dated October 27, and since then, no new scientific knowledge has been confirmed. Therefore, the Commission recognizes that this is the case where the substance and degree of adverse effects on human health are clear, as defined in Article 11, Paragraph 1, Item 2 of the Food Safety Basic Act (Act No. 48, 2003)”.

On December 27, 2011, the MHLW asked the Radiation Council for its opinions on the proposals of revisions of the "Ministerial Ordinance on Milk and Milk Products concerning Compositional Standards, etc." (Ministry of Health and Welfare Ordinance No. 52, 1951) and "Specifications and Standards for Foods, Food Additives, etc." (Ministry of Health and Welfare Notification, No. 370, 1959), prepared on the basis of the aforementioned draft standard limits presented by the Radioactive Material Countermeasures Working Group of the Food Sanitation Subcommittee of the Pharmaceutical Affairs and Food Sanitation Council on December 22. Following the Radiation Council's recommendations, the MHLW revised the ministerial ordinance and notification concerned on March 15, 2012, and the revised ministerial ordinance and notification was put into force on April 1. Provisional regulation values in the past and new standard limits are shown in Table IV-2.

Table IV-2 Comparison of standard limits on radioactive cesium in foods

Provisional regulation values		New standard limits	
Food category	Regulation value	Food category	Standard limit
Drinking water	200	Drinking water	10
Milk, dairy products	200	Infant foods	50
Vegetables	500	Milk	50
Grains	500	General foods	100
Meat, eggs, fish, etc.	500	Drinking water	10

Unit : Bq/kg

[Governmental Final Report] Chapter IV 5

e. New food product regulations based on 1 mSv per year

With regard to the provisional regulations, a health impact assessment by the Food Safety Commission pointed out the need to individually respond to persons highly susceptible to radiation due to genetic predispositions.

On March 29, 2011, the Food Safety Commission released a report entitled, "Emergency information regarding radioactive substances." The report presented the basic stance that radioactive substances in food products should be limited as much as possible, and that, in particular, pregnant women, women who are potentially pregnant, infants, and children should pay special attention to what they eat. The report paid further consideration to iodine and cesium but indicated that not enough information was available at the time. And it pointed to the need to continue food impact assessments, and the need to gather information on strontium.

On October 27, the Food Safety Commission compiled and submitted to MHLW a food health impact assessment which said that the radiation has an impact on health if the accumulated dose over the span of an individual's life is approximately 100 mSv or more, that children are more susceptible to radiation than adults, and that it is difficult to comment on the health impact of radiation when it amounts to 100 mSv or less. In response, MHLW worked to set new standards based on the Food Sanitation Act and applied those new standards from April 1, 2012. The new standard is set at 1 mSv/y and basically reflects the ICRP's public upper dose limit during normal times. However, the new standards are similar to the provisional regulations in that they were drafted only in consideration of the possibility of internal exposure through food.

[National Diet Report] Chapter 4, 4.4.3

Setting provisional regulations

Shipping restrictions for food and beverages were firstly judged on the basis of provisional regulations (refered to as provisional standards by TV news). The background of setting the

provisional regulations is described below.

The legal foundation for setting measures such as shipping restrictions for food is the Food Sanitation Act. Article 1 of this law is as follows: the objective of this law is to protect citizen health by implementing regulations or other measures required from the viewpoint of public health for the purpose of ensuring the safety of food. However, before the present accident, the criteria to implement measures, such as regulations, was not prepared for radioactive contamination such as in this accident. For this reason, the indices for restricting the intake of food and beverages given by the Nuclear Safety Commission (NSC) were used as provisional regulation values. The provisional regulation values of radioactive iodine and cesium are shown below.

核種	食品衛生法（1947年法律第233号）の規定に基づく食品中の放射性物質に関する暫定規制値（Bq／kg）	
放射性ヨウ素 （混合核種の代表核種：ヨウ素－131）	飲用水	300
	牛乳・乳製品	
	野菜類（根菜、芋類を除く）	2,000
	魚介類	
放射性セシウム	飲料水	200
	牛乳・乳製品	
	野菜類	500
	穀類	
	肉・卵・魚・その他	

注）100Bg／kgを超えるものは、乳児用調整粉乳及び直接飲用に供する乳に使用しないよう指導すること

The NSC gives indices for restricting the intake of food and beverages in the emergency preparedness guideline. These indices are an intervention level for use in an emergency and are not concentration criteria that show whether radioactive materials in food and beverages affect public health or not. On the basis of concepts of the International Commission of Radiological Protection (ICRP) and IAEA, as a foundation for setting protective measures, these indices were established using a 5 mSv/y effective dose (50 mSv/y in the case of a thyroid equivalent dose owing to radioactive iodine) as an avertable dose, taking into consideration the actual conditions of Japanese dietary life.

Protective measures such as shipping restrictions were actually conducted on the basis of these indices, but such indices had not been incorporated in the Food Sanitation Act, which is the foundation of the shipping restrictions. For this reason, the expression “provisional regulation values in the Food Sanitation Act” was used. To incorporate these indices, it is necessary to revise the Food Sanitation Act. However, as of the end of January 2012, the provisional regulation values had still been used continuously.

[Nongovernmental Report] Part 1 Chapter 2 Section 2

Estimation of internal exposure due to intake of food

Radioactive Material Countermeasures Working Group Food Sanitation Subcommittee Pharmaceutical Affairs and Food Sanitation Council (Dose assessment, etc.)

[Objective]

To help examine the risk management concept for food in the near future after the accident at Fukushima Daiichi NPS, the amounts of radioactive materials in Japanese daily diet and the committed effective dose (hereinafter “dose”) are estimated below.

[Method]

1. Group for estimation

In the case of deterministic dose assessment, “whole population”, “pregnant women”, “infants”, “embryos and fetuses”, and “nursing infants” were selected as groups for the estimation. In the case of probabilistic dose assessment, “below 6 years of age”, “7 to 12 years of age”, “13 to 18 years of age”, and “whole population” were targets of the estimation.

2. Radioactivity concentration in food used in estimation

Data (hereinafter "monitoring data") consolidated and published by the MHLW in the period between the occurrence of the accident and 31 August 2011 was used as the radioactivity concentration in food. Monitoring data below the detection limit was treated as 10 Bq/kg for Cs-134 and Cs-137. In the case of no monitoring data, 0 Bq/kg was assumed. The monitoring data of (1) food beyond provisional regulation values and (2) sea products of Fukushima prefecture were removed from the estimation because such foods had never been shipped.

3. Amount of food intake of Japanese people used in estimation

Amount of food intake was determined referring to the "Special Totaling Work Report on investigation of frequency and amount of food intake" published by the National Institute of Health and Nutrition as an investigation result entrusted by the Standard Review Section, Department of Food Safety, Pharmaceutical and Food Safety Bureau of the MHLW. Small categories in this report were used as a categoraization of food for estimating the amount of intake. Distribution of the amount of intake was determined refering to two results analyzed by Mrs. Rieko Matsuda, Food Director (National Institute of Health Sciences), using the Results of the National Health and Nutrition Survey and by Mr. Yoshitaka Godai, Researcher (Environmental Dynamics Study Division, the Institute for Environmental Sciences), using the amount of food intake of infants in Aomori prefecture.

4. Method of estimation of internal exposure owing to intake of radioactive materials in food

The following two methods were adopted for estimating internal exposure

4.1 Method of determistic dose assessment of internal exposure

A method to estimate the internal exposure per one month assuming that a person in a group continues to eat an average amount of food with a specific radioactivity concentration was applied to a deterministic dose assessment. In this trial calculation, the median value of the radioactivity concentration in food was used for the dose assessment in every category. Also, this may be with less possibility, the 90 percentile value of radioactivity concentration was used in the estimation conservatively assuming that a person in the group continues to eat highly contaminated food*.

* The median value, not the arithmetic mean value was used as the representative dose, because the radioactivity concentration in food did not show a normal distribution. This indicates that the dose of 50th person of 100 people sorted in dose order is the median value. A 90th percentile value means that 10% of these people have higher doses. It would be difficult to continue to eat food equivalent to the 90th percentile value in each category, which means it is a fairly conservative estimation.

4.2 Method of probabilistic dose assessment of internal exposure*

A method to estimate the median and 90 percentile of dose distribution obtained by calculating the virtual dose distribution for 1000 people and by multiplying a randomly selected radioactivity concentration from actual measurement results with a randomly selected amount of intake from the Japanese distribution was applied to a probabilistic dose assessment.

* Internal exposure is determined by multipying mass (amount of intake) of food intake by radioactivity concentration of the food. However, there is an individual difference in the amount of food intake and radioactivity also differs in each food. The probabilistic method is a way to estimate dose considering individual differences.

In the case of the probabilistic method, individually different values are expressed by using random numbers. (Dose distribution is estimated virtually determined as a variable using random numbers, assuming distribution of the variable, and using a model to determine the individually different value.)

5. Preassumption used in the other estimation

5.1 Dose conversion factor

Conversion factors to dose (mSv/month or mSv/year) shown in "Guideline for environmental monitoring (March 2008)" given by the Nuclear Safety Commission were used in the estimation. The conversion factor for I-131 was used for radioactive iodine and those for Cs-134 and Cs-137 were used for radioactive cesium. Dose conversion factors given in ICRP Pub.88 and Pub.95 were used for embryo and fetus, and nursing infant.

5.2 Estimation period

Internal exposure was estimated for two cases every month using monitoring data obtained in March, April, May, June, July and August, for one year. Monitoring data after September were assumed to be the same as data for August. The intakes for pregnant woman, and embryo and fetus were assumed for nine months.

5.3 Target radioactive nuclides

Intaken radioactive materials were calculated for I-131, Cs-134 and Cs-137, regarding I-131 as radioactive iodine and the summation of Cs-134 and Cs-137 as radioactive cesium. Radioactive iodine in the food category was assumed to decay according to its physical half life. Physical decay was not considered in the estimation for radioactive cesium.

5.4 Treatment for special food

Processed food with available measurement data was used. It is assumed for tea in the processed foods that 10g of tea leaf is used to make 300ml of green tea and 60% of radioactive cesium in tea leaf is transfered into green tea.

[Results]

1. Deterministic dose estimation (national average is used for amount of intake)

(1) Dose estimation using actual measurement results in 6 months (March to August 2011)

A. Continuous intake of food with median value of radioactive concentration

摂取期間	全年齢	集団の特性			
		妊婦	小児	胎児	乳児（母乳摂取のみ）
3月	0.012	0.011	0.036	0.024	0.021
4月	0.007	0.006	0.013	0.007	0.005
5月	0.007	0.006	0.013	0.007	0.005
6月	0.008	0.007	0.008	0.003	0.001
7月	0.009	0.008	0.009	0.004	0.002
8月	0.008	0.007	0.008	0.003	0.001
3～8月の合計	0.051	0.045	0.087	0.048	0.035
年間合計	**0.099**	**0.066**	**0.135**	**0.057**	**0.041**

B. Continuous intake of food with 90 percentile value of radioactive concentration*

摂取期間	全年齢	集団の特性			
		妊婦	小児	胎児	乳児（母乳摂取のみ）
3月	0.041	0.035	0.076	0.092	0.082
4月	0.026	0.022	0.049	0.036	0.029
5月	0.026	0.022	0.021	0.012	0.007
6月	0.023	0.020	0.022	0.013	0.007
7月	0.016	0.014	0.011	0.006	0.003
8月	0.016	0.013	0.013	0.006	0.002
3～8月の合計	0.148	0.126	0.192	0.165	0.130
年間合計	**0.244**	**0.165**	**0.270**	**0.183**	**0.142**

* The situation of a continuous intake of food with 90 percentile radioactivity concentration leads to a conservative estimation, which is difficult to occur in normal life.

(Note for both A and B)

* Infant: 1 to 6 years of age.
* The dose for pregnant woman is small because the amount of intake for pregnant woman is smaller than that of the general population group.
* The annual dose estimation for pregnant woman, and embryo and fetus shows a total for a pregnancy period of 9 months.

2. Probabilistic dose estimation

Below 6 years of age

摂取期間	中央値	90パーセンタイル
3月	0.009	0.022
4月	0.007	0.013
5月	0.008	0.014
6月	0.007	0.013
7月	0.008	0.012
8月	0.008	0.011
3～8月の合計	0.047	0.085
年間合計	**0.095**	**0.151**

7-12 years of age

摂取期間	中央値	90パーセンタイル
3月	0.028	0.074
4月	0.011	0.022
5月	0.009	0.016
6月	0.008	0.016
7月	0.008	0.012
8月	0.008	0.011
3～8月の合計	0.072	0.151
年間合計	**0.120**	**0.217**

13-18 years of age

摂取期間	中央値	90 パーセンタイル
3 月	0. 020	0. 057
4 月	0. 009	0. 020
5 月	0. 010	0. 018
6 月	0. 008	0. 017
7 月	0. 008	0. 012
8 月	0. 012	0. 016
3～8 月の合計	0. 067	0. 140
年間合計	**0. 139**	**0. 236**

Whole population

摂取期間	中央値	90 パーセンタイル
3 月	0. 008	0. 029
4 月	0. 006	0. 016
5 月	0. 007	0. 018
6 月	0. 007	0. 016
7 月	0. 008	0. 015
8 月	0. 008	0. 013
3～8 月の合計	0. 044	0. 107
年間合計	**0. 092**	**0. 185**

[Discussion and issues]

1. Doses due to intake of food under the situation controlled by provisional regulation values were estimated to be lower than the naturally received dose* owing to the intake of an average amount of food.
   * The annual committed effective dose (Japanese average) owing to the intake of natural radioactive materials (radioactive potassium, etc.) is about 0.4 mSv. In addition, the annual committed effective dose owing to the intake of natural radioactive materials (polonium 210) has a variation of 0.2 mSv to 0.8 mSv. Taking into consideration such a variation, the additional dose owing to the intake of food after the Fukushima Daiichi accident would not be so high.
2. There may be a possibility that this result leads to an underestimation for individuals who eat only food including a high level of radioactivity. To clarify the actual situation, a total diet study* in response to the objectives must be effective.
   * A method to estimate the intake amount of specific chemical materials in a normal daily diet.
   * Investigation of intake and radioactive contamination of food will be started after the third revised budget is confirmed.
3. The validity and meaning of this result should be verified and analyzed in comparison with other investigations of internal exposure and total diet studies.
4. The contribution of nuclides other than target radioactive nuclides should be estimated by using a scaling factor of radioactive cesium (ratio of nuclides other than radioactive cesium).

[MHLW HP (30 Oct. 2011)]

Estimation of amount of intake of radioactive materials in food within one day

1 Objective

To estimate the amount of intake of radioactive materials in food in a normal diet, focusing on food that is located in one of exposure pathways to radioactive materials.

2 Method

2.1 Estimation of market bascket sample (MB sample)

(1) Overview

Food was purchased in 12 regions (Hokkaido, Iwate, Fukushima (Hamadori, Nakadori, and Aizu regions), Tochigi, Ibaragi, Saitama, Kanagawa, Niigata, Osaka, and Kochi prefectures) in February and March 2012. Fresh food was bought from local or neighborhood products when possible. On the basis of the intake average according to the food and the area in the national health and nutrition examination survey, one days intake of radioactive materials (Bq/man/day) in a normal diet was calculated by measuring the mass of food, separated into 13 categories of food as it is or after cooking, making MB samples by mixing and unified them, and analyzing radioactive cesium (Cs-134 and Cs-137) and radioactive potassium (K-40: natural nuclide) as MB samples including drinking water. Moreover, the committed effective dose (mSv/year) was calculated when a person continued to consume average meals for one year.

(2) Measurement method

MB samples in 2 liter marinelli containers were measured for 22 hours using a Ge semiconductor detector. The detection limit was dependent on the samples, but was about 0.1 Bq/kg for Cs-134 and Cs-137. When the concentration in the sample was lower than the detection limit, the amount of intake was calculated by making the concentration half of the detection limit. When a background count rate was observed, the background value was subtracted from the count rate of the sample. The concentration was corrected as of the day of the collection of food after taking into consideration the decay of radioactive cesium.

2.2 Estimation using samples from meals prepared

(1) Overview

Meal sets for an absent person were collected from families in 9 regions (Hokkaido, Iwate, Fukushima, Tochigi, Ibaragi, Saitama, Niigata, Oosaka, and Kouchi prefecture) from March to May 2012. The meals for one whole day for three males and females in the six age categories [baby (below 1 year of age), infant (1 to 6 years of age), child (7 to 12 years of age), youth (13 to 18 years of age), adult (19 to 60 years of age), and senior (retires over 60 years of age)] and three pregnant women, that is for 39 persons as a total, were collected as the samples in each region. In the case of Fukushima prefecture, three samples each were collected from the meals for one person in Hamadori, Nakadori and Aizu regions. Analyzing radioactive cesium (Cs-134 and Cs-137) and K-40 in these samples, the amount of one day's intake of radioactive materials (Bq/man/day) and the committed effective dose (mSv/year) calculated when a person continued to have an average meal for one year were obtained.

(2) Measurement method

Since the water content of the meal sample for an absent person is generally high, it was measured using a Ge semiconductor detector after evaporating the water on a hot plate, reducing the volume, and homogenizing the mixture, as appropriate. As the meal size depended on the age category, a U8 container, 200ml container and 1 liter marinelli container were used according to the sample size. The measurement time was limited to 24 hours. For this reason, the detection limit varied with the sample and was 0.04 to 1.8 Bq/kg for Cs-134 and Cs-137, and 0.53 to 14 Bq/kg for K-40. The maximum detection limit (24 hour measurement using a U8 container) was

found in the case of a baby's breast feeding (20g in a whole day). When the concentration in the sample was lower than the detection limit, the amount of intake was calculated by making the concentration half of the detection limit. When a background count rate was observed, this background value was subtracted from the count rate of the sample. The concentration was corrected as of the day of the collection of food after taking into consideration the decay of radioactive cesium.

3. Overview of the results

3.1 Results for MB samples

Among all 168 samples, Cs-134, Cs-137 and K-40 were detected in 75, 88 and 147 samples, respectively.

The amounts of one day's intake of radioactive materials in food were estimated to be 0.17 to 1.7 Bq/man/day for Cs-134 and Cs-137, and 69 to 89 Bq/man/day for K-40. The committed effective doses were estimated to be 0.0009 to 0.0094 mSv/year for Cs-134 and Cs-137, and 0.16 to 0.20 mSv/year for K-40, as shown in Table 1 and Figure 1. The committed effective doses for radioactive cesium were just lower than 1% of 1 mSv. The amounts of one day's intake of radioactive material estimated from samples made in three regions (Miyagi and Fukushima (Nakadori) prefectures, and Tokyo metropolitan area) from September to November 2011 were 0.42 to 3.4 Bq/man/day for Cs-134 and Cs-137, and 77 to 91 Bq/man/day for K-40. The committed effective doses were 0.0024 to 0.019 mSv/year for Cs-134 and Cs-137, and 0.18 to 0.21 mSv/year for K-40. Comparing these results, it was made clear that the amount of intake of radioactive cesium significantly reduced, but the amount of K-40 did not reduce.

Table 1 Committed effective doses for radioactive cesium and potassium in MB samples.

地域	放射性セシウム (mSv/year)	放射性カリウム (mSv/year)
北海道	0.0009	0.157
岩手	0.0094	0.202
福島(浜通り)	0.0063	0.186
福島(中通り)	0.0066	0.189
福島(会津)	0.0039	0.179
栃木	0.0090	0.180
茨城	0.0044	0.194
埼玉	0.0039	0.175
神奈川	0.0033	0.156
新潟	0.0023	0.167
大阪	0.0016	0.160
高知	0.0012	0.177

* Committed effective dose coefficients (Sv/Bq) for adults given in ICRP Publication 72 were used in the conversion of Bq to Sv.

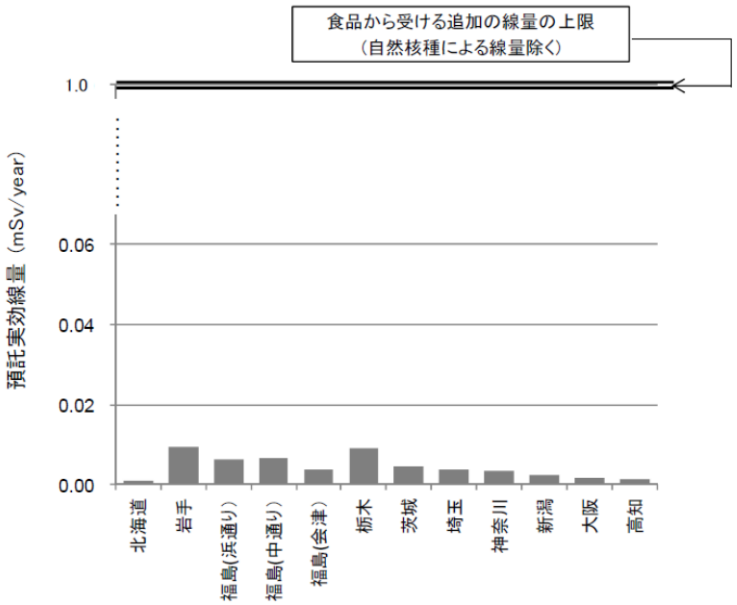


Figure 1 Committed effective doses for radioactive cesium in MB samples.

3.2 Results of samples of meal set for absent person

The committed effective dose estimated from the measurement results of radioactivity concentrations in each region are shown in Table 2 and Figure 2. The average committed effective dose was estimated to be 0.0012 to 0.0039 mSv/year for Cs-134 and Cs-137, and 0.17 to 0.21 mSv/year for K-40. The maximum value of regional average (Ibaragi prefecture) owing to radioactive cesium was merely 0.0039 mSv/year and below 1% of 1 mSv. The average committed effective dose of each age category is shown in Table 3. The committed effective doses for babies and infants were lower than those for youths.

The maximum committed effective dose in all the samples was 0.027 mSv/year (Fukushima prefecture). The maximum 90 percentile value calculated in each region was 0.0091 mSv/year (Ibaragi prefecture). In this manner, if meals with relatively high radioactivity concentration are continued for one year, committed effective dose in one year would be one order of magnitude lower than 1 mSv, although doses due to meals showed a variation in the same region.

Table 2 Committed effective dose of radioactive cesium and potassium estimated from samples of meal set for absent person

地域	放射性セシウム (mSv/year)		放射性カリウム (mSv/year)
	平均値	90 パーセンタイル値	平均値
北海道	0.0013	0.0018	0.208
岩手	0.0035	0.0075	0.201
福島	0.0022	0.0035	0.187
栃木	0.0030	0.0078	0.204
茨城	0.0039	0.0091	0.214
埼玉	0.0018	0.0043	0.174
新潟	0.0015	0.0022	0.170
大阪	0.0012	0.0016	0.166
高知	0.0012	0.0016	0.196

* Committed effective dose coefficients (Sv/Bq) for adults given in ICRP Publication 72 were used in conversion of Bq to Sv.

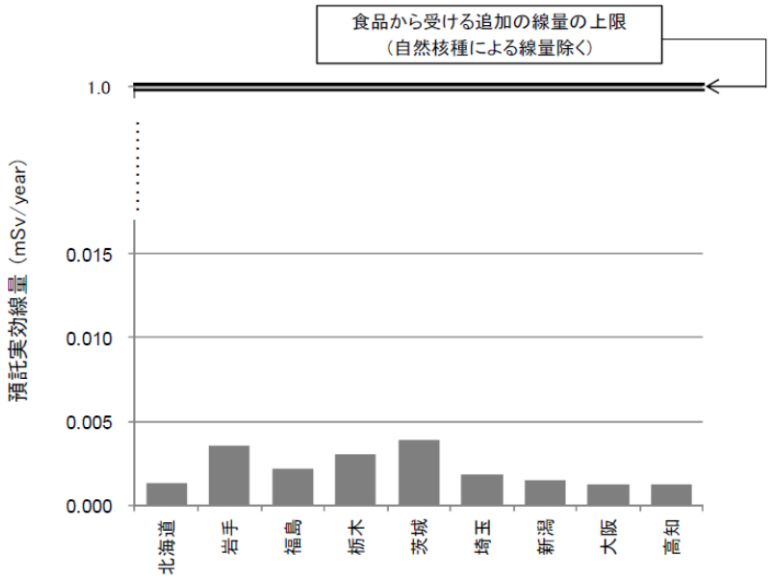


Figure 2 Committed effective doses for radioactive cesium in samples of meal set for absent person

Table 3 Average committed effective dose for each age category estimated from samples of meal set for absent person

地域	放射性セシウム (mSv/year)			
	乳児 (1 歳未満)	幼児 (1～6 歳)	小児 (7～12 歳)	青少年以上 (13 歳～)
北海道	0.0011	0.0008	0.0010	0.0015
岩手	0.0013	0.0026	0.0018	0.0048
福島	0.0019	0.0008	0.0010	0.0031
栃木	0.0010	0.0020	0.0018	0.0042
茨城	0.0027	0.0029	0.0027	0.0048
埼玉	0.0007	0.0009	0.0012	0.0026
新潟	0.0009	0.0010	0.0013	0.0019
大阪	0.0007	0.0007	0.0007	0.0010
高知	0.0007	0.0012	0.0010	0.0014

3.3 Comparison of results between MB samples and samples of meal set for absent person

The committed effective doses in one year for K-40 estimated from MB samples and samples of meal set for absent person were similar values. On the other hand, the committed effective doses for Cs-134 and Cs-137 in the MB samples were found to be higher than those for the samples of meal set for absent person. One of the reasons may be that foodstuffs in the MB samples were purchased within local or neighbor products, but those in the samples of meal set for absent person were collected normally without restrictions.

[MHLW HP (11 Mar. 2013)]

The following isssues can be raised in association with criteria for food and beverages.

Radiological protection criteria – criteria for food and beverages - comprehensiveness of food categories

- Since in the provisional regulatory values (by 31 March 2012) for radioactive materials contained in foods, the restriction values for radioactive iodine in fish and foods not to consumed directly, e.g., tea leaves, were not specified, much confusion occurred.

Radiological protection criteria – criteria for food and beverages – universal use for various types of accident

- Since the new regulatory value for food and beverages enforced on 1 April 2012 was derived for only radioactive cesium on the basis of 1mSy/y as an internal exposure dose and can be applied to the current situation after the present accident, it cannot be universally used as a criterion for emergency preparedness where various types of accident should be considerd.

Radiological protection criteria – criteria for food and beverages – approach to dose criteria

- In the derivation of the new regulatory value for food and beverages enforced on 1 April 2012, 1mSv was adopted as a dose criterion, strictly shifting from 5mSv; nevertheless, the estimated dose due to intake of contaminated foods was sufficiently low and was determined without full discussion with stakeholders associated with the production, distribution, and consumption of foods.

- Protective criteria for temporary entry into restricted zones

Descriptions about protective criteria for temporary entry into restricted zones are given in **[Governmental Interim Report]** in the following way.

g. Establishment of restricted areas and temporary access to the restricted areas

Following an evacuation order issued at 18:25 on March 12, residents in regions within a 20km radius were evacuated to areas outside the designated regions. During their ongoing and prolonged life as evacuees, some of the residents started to return home to the evacuation zones to collect their belongings. The Nuclear Emergency Response Local Headquarters (Local NERHQ) submitted a report on this situation the Government Emergency Response Headquarters (NERHQ). Around and after March 24, the NERHQ started discussions on how to deal with this situation and enthusiastically work on this matter corresponding to, Chief Cabinet Secretary Edano's directive issued on March 28.

On March 28, as a measure to prohibit residents from entering the evacuation zones, the Local NERHQ provided all the cities, towns and villages concerned with a notification of "Prohibition of access to evacuation zones within a 20km radius". On March 30, the Prefectural Headquarters also notified all evacuation centers and other facilities of this measure.

Based on discussions about temporary access to the restricted areas and mutual consultation with the relevant heads of cities, towns and villages, the NERHQ had already asked the NSC for its advice on the implementation of restricted areas within a 20km radius of the Fukushima Dai-ichi NPS, and the NSC replied that it had no objection to the NERHQ' ideas. At 11:00 on April 21, the NERHQ issued a directive to the heads of all the cities, towns and villages concerned that restricted areas should be established within the specified radius.

Additionally, temporary access to an established restricted area within a 20km radius of the Fukushima Dai-ichi NPS was permitted only to those individuals who were exposed to air radiation dose rate lower than 200μSv/h and were planning to stay in the area for five hours. This value of 200μSv/h was obtained by assuming five hours consisting of a three-hour round trip from the boundary of the 20km radius to the furthest access area and two hours spent at home or other access points, and by dividing 1mSv of annual permissible radiation dose, advised by the NSC, by 5.

The steps for applying for temporary access to an established restricted area were as follows: first, all applications for temporary access to an established restricted area were accepted at an information booth established by the Fukushima prefectural government; lists of names were sorted by cities, towns or villages and sent to the respective municipalities; those lists of names were further sorted by regions and grouped into smaller districts; and then preferred dates were arranged. Additionally, it was decided that the staff of cities, towns or villages should attend to those temporarily accessing the established restricted areas.

However, this work created a great burden for cities, towns and villages suffering from the nuclear accident and the tsunami. Thus a total of approximately 5,560 staff was dispatched from METI and other government offices to support the related work.

Initially, areas within a 3km radius of the Fukushima Dai-ichi NPS were excluded from this initiative to temporarily access restricted areas. The zones within a 3km radius of the Fukushima Dai-ichi NPS were those to which were initially issued with evacuation orders. In a situation where the impact of the nuclear accident had not been settled, it was necessary to take successive measures against an unforeseen emergency.

Subsequently, the conditions of the nuclear reactors at the Fukushima Dai-ichi NPS stabilized. In response to this, on August 9, NERHQ confirmed that it was safe to enter the areas within a 3km radius of the Fukushima Dai-ichi NPS and issued an announcement to that effect. Thus, temporary access to those established restricted areas in Okuma-town and Futaba-town was officially granted.

[Governmental Interim Report] Chapter V 3

The following isssues can be raised in association with protective criteria for temporary entry into restricted zones.

Radiological protection criteria – protective criteria for temporary entry into restricted zones - balance among other risks

- Irrespective of the ambient dose level in the residence, the maximum time spent at home during temporary entry was limited to 2 h, and the total time taken for the round trip from the relay point to each home was limited to 5 h.

- Dose criteria for emergency work

Descriptions about dose criteria for emergency work are given in **[Governmental Interim Report]**, **[Governmental Final Report]**, **[National Diet Report]** and **[TEPCO Report]** in the following way. Protective criteria for governmental officials including the Self-Defense Forces and local government employee such as police officer and fireman are described in **[Governmental Interim Report]**.

(2) Radiation dose limit for radiation workers in an emergency

a. Raising the exposure limit to 250mSv

TEPCO executives, who had been staying at the Prime Minister's Office since the accident at the Fukushima Dai-ichi NPS, were informed by corporate headquarters that radiation levels at the site were rising. The TEPCO executives recognized that it might be impossible to continue operations to manage the nuclear accident if they insisted on the current legal exposure limit and asked the NSC and NISA for their advice. In response to this request, at the Prime Minister's Office in the afternoon of March 14, it was decided that the exposure limit for emergency operations should be increased from 100mSv to 250mSv. At that time, consideration was given to the fact that ICRP Pub. 103 stipulates that the exposure limit for emergency workers should be 500mSv to 1,000mSv, 250mSv is half the lower limit, and the "Regulatory Guide for Reviewing Nuclear Reactor Site Evaluation and Application Criteria" developed by the Japan Atomic Energy Commission in 1964 describes that the exposure to be temporarily allowed based on the recommendations of the guide is 250mSv.

In response to this implementation, on the same day, the Ministry of Health, Labor and Welfare and METI worked together to prepare a ministry order and a notice to the effect that from the date when a nuclear emergency is declared to the date when the nuclear emergency is lifted in a zone where emergency countermeasures must be taken the exposure limit should, in unavoidable circumstances, be 250mSv. Sometime after midnight the same day, they asked MEXT Radiation Council for advice. The Council debate the proposed exposure limit by email throughout the day until just before dawn the following day and replied that it was reasonable. In response to this advice, the Ministry of Health, Labor and Welfare and METI formulated a ministry order and a notice to that effect, dated April 14 and the ministry order and notice were issued (published in an official gazette) on March 15.

b. Discussion on raising the exposure limit to 500mSv

On March 17, three days after raising the exposure limit for emergency workers from 100mSv to 250mSv, a discussion was held at the Prime Minister's Office to raise the exposure limit even further to 500mSv. In response to this, the Ministry of Health, Labor and Welfare and METI started to prepare a plan to that effect within the Ministries. However, there was ultimately no instruction to that effect from the Prime Minister's Office.

c. Lowering the exposure limit to 100mSv

On August 30, the Ministry of Health, Labor and Welfare started discussing lowering the exposure limit for emergency operations back to 100mSv. The Ministry, under mutual arrangement with TEPCO, METI, and other organizations, excluding staff who had already been involved in this arrangement before the exposure limit was raised, started to implement a ministry order63 where the phrase "in unavoidable circumstances" should be changed to “in unavoidable circumstances and in circumstances the Minister of Health, Labor and Welfare deems unavoidable" for the "ministry order on the special rules of Ordinance on the Prevention of Ionizing Radiation Hazards to respond to the events resulted from the 2011 Tohoku District-off the Coast of Pacific Ocean Earthquake", and asked the Council of Labor Policy for advice on October 24. The Council replied that it was reasonable. The ministry order became effective as of November 1.

(Omission)

a. Radiation dose limit for government employees in emergency works

As per the description in Section (1) c above, Article 4, Paragraph 3 of the National Personnel Authority Rules 10-5 prescribes that the dose limit for government employees in emergency works shall be 100mSv, which is the same for general workers.

On the morning of March 16, a staff member of National Personnel Authority in charge of National Personnel Authority Rules learned via a news report that both the MHLW and METI had raised the radiation dose limit for workers engaged in emergency works. With regards to

national government employees employed in regular government service, it is likely that, for example, Nuclear Safety Inspectors might be engaged in emergency works at a nuclear power station. Hence, a staff member immediately asked MHLW to provide him with the relevant documents. To discuss the matter, the staff member also phoned a Defense Ministry staff member in charge of a "Ministry of Defense official directives concerning staff health care" that is quoted from National Personnel Authority Rules 10-5. At approximately 18:00 on March 16, the same staff member asked the MEXT Radiation Council advice on a ministry order revision that the exposure limit should be 250mSv to respond to events resulting from the 2011 Tohoku District-off the Pacific Ocean Earthquake from the date when the nuclear emergency is declared to the date when the nuclear emergency is lifted, in a zone where emergency countermeasures must be taken in unavoidable circumstances.. The Radiation Council had a debate on the proposed dose limit by email from 18:30 to 19:30 that day. They reached a consensus and replied that it was reasonable. In response to this advice, the National Personnel Authority revised part of the Nuclear Disaster Special Measures Law, Article 28 of the National Personnel Authority Rules 10-5, as follows: "In response to events resulting from the 2011 Tohoku District-off the Pacific Ocean Earthquake from the date when the nuclear emergency is declared (pursuant to Paragraph 2 of Article 15 of the Nuclear Disaster Special Measures Law enacted in 1999, No. 156) to the date when the nuclear emergency is lifted (pursuant to "Paragraph 4 of the Article, in a zone where emergency countermeasures must be taken prescribed in Paragraph (8) of Article 17 of the same Law), in unavoidable circumstances the exposure limit "100mSv" (prescribed in Item (3) of the same Paragraph), concerning the application of the provision of Paragraph 3 of Article 4, should be replaced with the dose limit of 250mSv." This revision was published in a government gazette the next day, March 17, and took effect that day.

Additionally, Nuclear Safety Inspectors who worked in the Fukushima Dai-ichi NPS safety inspectors' office collecting information after the nuclear accident (refer to Section III2(7) above) were not directly engaged in emergency operations in reactor buildings.

Defense Ministry staff, including Self Defense Force personnel, is government employees for special government service and they are not directly subject to National Personnel Authority Rules. However, Paragraph 2 of Article 26 of "Ministry order on health care management of Defense Ministry staff" stipulates that "the limit of effective dose equivalent for directees (workers under management) who are engaged in emergency works to prevent radiation hazards shall comply with the rules of staff who are engaged in emergency works (Paragraph 3 of Article 4 of National Personnel Authority Rules 10-5. Hence, the limit for the effective dose equivalent shall comply with the rules of National Personnel Authority Rules 10-5.

In response to the declaration of the nuclear emergency state on the night of March 11, at 19:30 on the same day the Self Defense Forces issued a "Self-Defense Force action command concerning the implementation of nuclear disaster dispatch service for nuclear emergency events at the TEPCO Fukushima Dai-ichi Nuclear Power Station and Fukushima Dai-ni Nuclear Power Station." From March 17, Self-Defense Force personnel were engaged in flushing water out into a spent fuel pool, but none of them received a radiation dose exceeding 100mSv, which was the previous radiation dose limit prior to being changed.

b. Radiation dose limit for local government employees in emergency works

Provisions of the Industrial Safety and Health Act, rather than those of the National Personnel Authority Rules, are applied to local government employees including police officers and firemen. Hence, the radiation dose limit for local government employees in emergency operations was raised to 250mSv on March 14.

A guideline on the radiation dose limit for police officers and firemen contained in the NE Guideline prepared by the NSC in June, 1980, stipulates that "the upper limit of radiation dose, especially for those who are engaged in emergency works in a nuclear accident site among those engaged in disaster prevention works (for example, staff other than radiation workers employed at the nuclear power station as well as experts dispatched from the national government, those who are employed at police or fire stations. Self-Defense Force personnel, those who are employed in urgent medical care service), shall be 100mSv in terms of effective dose for

emergency works in urgent and unavoidable circumstances to prevent a disaster from worsening and to save lives. Additionally, the "Manual for firefighting activities at nuclear power facilities" prepared by the Fire and Disaster Management Agency in March 2001 stipulates that the "radiation dose limit shall be 100mSv for emergency works to save lives. There were no changes in them.

None of the mobile police officers and firemen engaged in flushing water out into a spent fuel pool was exposed to radiation doses exceeding 100mSv.

[Governmental Interim Report] Chapter V 4

b. Discussion on raising the exposure limit to 500mSv

On March 17, three days after raising the exposure limit for emergency workers from 100mSv to 250mSv, Special Advisor Hosono, in light of the facts that the SDF was scheduled to begin discharging water from its water cannon trucks into the spent nuclear fuel pool of Unit 3 of the Fukushima Dai-ichi NPS from the same day and that on the previous day, on March 16, the SDF gave up on the sprinkling of water from helicopters due to the high radiation dose level, thought that it is necessary to raise the exposure dose limit further up to 500mSv in order to avoid situations where the work at the nuclear power station cannot be done due to the exposure limit, while paying heed to the recommendations of the International Commission on Radiological Protection (ICRP). Special Advisor Hosono first asked House of Representatives Member Akihisa Nagashima (hereinafter referred to as "House of Representatives Member Nagashima"), former Parliamentary Vice-Minister of Defense, to sound out the National Personnel Authority, the Ministry of Health, Labour and Welfare and the Ministry of Economy, Trade and Industry about a possible plan to raise the radiation exposure limit. When House of Representative Member Nagashima approached National Personnel Authority President Takeshi Erikawa, Senior Vice Minister of Health, Labour and Welfare Yoko Komiyama, and Senior Vice Minister of Economy, Trade and Industry Motohisa Ikeda to sound them on a possible plan to raise the dose limit, they did not express any particular opposition. So, Special Advisor Hosono proposed to Prime Minister Kan that the dose limit should be raised again.

When Prime Minister Kan called relevant cabinet ministers, including Minister of Health, Labour and Welfare Ritsuo Hosokawa, METI Minister Banri Kaieda and Minister of Defense Toshimi Kitazawa (hereinafter referred to as "Defense Minister Kitazawa") and National Public Safety Commission Chairman Kansei Nakano (hereinafter referred to as "National Public Safety Commission Chairman Nakano"), to his office at around 18:30 on March 17 to hear their opinions about the raising of the dose limit, Minister of Defense Kitazawa and National Public Safety Commission Chairman Nakano voiced negative or cautious views about it. In the evening of the same day, Minister of Defense Kitazawa again conveyed his opinion against it to Prime Minister Kan. Under these circumstances, Prime Minister Kan decided against the raising of the exposure dose limit.

[Governmental Final Report] Chapter V 3

1. The government increases the dose limit for nuclear power plant workers

In response to the accident, based on the opinions of the Radiation Council, MHLW set forth a ministerial ordinance concerning special provisions in Article 7, paragraph 2 of the Rules for Prevention of Damage from Ionizing Radiation (hereafter, "Ionization Rules") on March 14, 2011. Similarly, METI, based on the opinions of the Radiation Council, released a notice on special provisions pertaining to Article 9, paragraph 2 of the provisions of the Rules for Commercial Nuclear Power Reactors concerning Installation, Operation, etc. (hereafter, "Commercial Reactor Rules"). Consequently, the upper limit for the exposure dose received by workers performing emergency operations at the Fukushima Daiichi Nuclear Power Plant was increased from 100mSv to 250mSv. After March 16, the advisory team of the Cabinet Secretariat advised the Prime Minister's Office to further increase the upper limit to 500mSv for emergency operations. Discussions on this only took place at the Prime Minister's Office, however, and internal reviews

of MHLW were not conducted.

On April 28, 2011, MHLW, in accordance with a request from METI, announced that should radiation workers involved in emergency operations at Fukushima Daiichi Nuclear Power Plant engage in radiation work other than emergency operations, their exposure dose would be in violation of the Ionization Rules, only if it exceeds 50mSv per year—not in combination with the exposure dose from emergency operations at the nuclear power plant, but counting only the exposure dose from non-emergency operations (Ki-Hatsu 0428 No.1). METI explained to MHLW that due to a shortage of workers engaged in emergency operations at the Fukushima Daiichi plant, workers from other nuclear power plants had offered their support. However, if the exposure dose from emergency operations is counted toward the upper limit of the dose that nuclear power plant workers receive during normal operations (50mSv/year or 100mSv/5 years), then the support workers would have been unable to work upon returning to their original nuclear power plants. The above-stated notification, by decree, enabled the work carried out at Fukushima Nuclear Power Plant to be separated from the ordinary operations of these volunteers. The cumulative exposure dose received by the volunteer workers remained unchanged. Health effects would still be considered in line with the LNT model.

[National Diet Report] Chapter 4, 4.4.5

(5) Exposure Dose Standards and Screening Guidelines in Times of Emergency

In responding to the Fukushima Daiichi NPS accident, judging from the work environment, it was clear that accumulated radiation exposure would increase, and there was a concern in the ability to continue accident response work within the dose limits enforced at the time. Since the dose limit during times of emergency stipulated by law at the time was 100mSv, TEPCO, via TEPCO employees working at the Official Residence, consulted with the NSC and NISA in regard to reconsideration of dose limits stipulated by law. Thereafter when the ERC Health Physics Team at the Headquarters was contacted by the Official Residence in regard to raising dose limits, the response was given that it would help if dose limits were raised since it was difficult to continue working while abiding by those limits. In response to these activities, on the afternoon of March 14, at the Official Residence, it was decided that the dose limit in emergency works would be raised from 100mSv to 250mSv. Although TEPCO is not in a position to know the basis for setting the limit at 250mSv, according to the Interim Report by the Government's Investigation and Verification Committee on the Accident at the Fukushima Nuclear Power Station of Tokyo Electric Power Company (government’s accident investigation committee), it appears that this value was decided in consideration for either half value of the lower dose limit during emergencies stipulated by the International Commission on Radiological Protection (ICRP) or an indication value determined provisionally by the Japan Atomic Energy Commission.

A debate in regards to the methods for applying these dose rates for doses received during emergency work ensued. Namely, whereas the emergency dose limit would be applied when engaging in emergency work at the Fukushima Daiichi NPS, the normal dose limit (100mSv/5 yrs or 50mSv/yr) would be applied when working at other nuclear facilities, etc. thereafter, so the question was whether to add the dose received during emergency work to the latter or to handle it as a separate incident. An opinion was conveyed through METI that the Interim Report by the Radiation Council General Assembly that summarized the results of debating the acceptance of ICRP and ICRP 2007 recommendations indicates that emergency work doses will be treated separately from normal work doses, and in light of a resolution of the accident at the Fukushima Daiichi NPS and a smooth handling of upcoming periodic inspection, etc. on nuclear power facilities nationwide, doses received during emergency work should be treated separately from the standpoint of normal work dose limit management (emergency work doses will be kept independent from normal work doses and separate dose limits will be applied to each). However, the Ministry of Health, Labor and Welfare issued an official notice that stated that when managing dose limits during normal work if a worker has a history of engaging in emergency work the doses received during that work shall be included and the limit of 100mSv/5 years shall

be observed.

The Ministry of Health, Labor and Welfare took the initiative in deliberating this issue of emergency dose limits thereafter and on November 1, a ministerial ordinance was issued that stated that the dose limit shall be returned to 100mSv, except when stipulated by the Minister of Health, Labor and Welfare in cases of emergency where it cannot be especially avoided, and excluding workers who are engaged in emergency work prior to issuance of the ministerial ordinance.

[Tepco Report] Chapter 13 Section 2(5)

The following isssues can be raised in association with dose criteria for emergency work.

Radiological protection criteria – dose criteria for emergency work – dose limit taking life-saving work into account

- In the second interim report on the incorporation of the 2007 Recommendations of the ICRP into domestic systems, the Basic Committee of the Radiation Council proposed to match the dose limits to internationally recommended values, taking into consideration that opportunities to participate in international activities were increasing for domestic workers, because the current restriction criteria in Japan (dose limit, 100 mSv) interfered with emergency medical care and other essential operations.

- On the other hand, in response to the present accident, 250mSv was adopted as a dose limit for emergency workers. This value is lower than the internationally approved principles and the recommended value of the 2007 Recommendations of ICRP (emergency medical care, no restriction; other emergency rescue operations, 1,000 or 500 mSv; other rescue operations, 100 mSv).

Radiological protection criteria – dose criteria for emergency work – treatment of individual doses received in an emergency situation

- In the second interim report on the incorporation of the 2007 Recommendations of the ICRP into domestic systems, it was indicated that emergency work doses will be treated separately from normal work doses. However, the Ministry of Health, Labor and Welfare (MHLW) issued an official notice stating that when managing dose limits during normal work, if a worker has a history of engaging in emergency work, the doses received during such work should be included and the limit of 100mSv/5 years should be applied.

(b) Radiation exposure of residents

Dose assessment for residents is not sufficient in the investigative reports. Work to

clarify the dose of actual residents is important issue.

・Estimation of thyroid equivalent dose of radioactive iodine by simple measurement

Descriptions about estimation of thyroid equivalent dose of radioactive iodine by simple measurement are given in **[Governmental Final Report]** and **[National Diet Report]** in the following way.

(b) The retrospective estimation of release source information by SPEEDI and implementation of investigation on the exposure of infant thyroid glands to radiation

As described in Chapter V 2. (3) b. and Chapter V 3. (2) a. of the Interim Report, starting around March 17, the NSC performed the SPEEDI retrospective estimation of the release source information. On March 23, the NSC performed a SPEEDI infant thyroid gland equivalent dose calculation based on a limited number of monitoring results. As a result, the NSC estimated that there were areas with high equivalent doses beyond the designated evacuation zone to the northwest and south of the Fukushima Dai-ichi NPS. The NSC took this fact seriously and reported it to the Prime Minister's Office. After discussions at a meeting presided over by Prime Minister Naoto Kan (hereinafter referred to as "Prime Minister Kan"), joined by Cabinet Secretary Advisor Kosako and such experts as Kazuo Sakai, director of the Research Center for Radiation Protection, National Institute of Radiological Sciences, it was concluded that since the high dose rates, that represent the values when one stays outdoors for 24 hours, are overestimated, the evacuation zones should not be expanded immediately and investigation on the exposure of infant thyroid glands to radiation should be conducted to confirm the data values based on actual measurement.

Therefore, on March 25, the NSC requested NERHQ to conduct investigation on the exposure of infant thyroid glands to radiation covering those aged between one and 15 in the stay-indoors zones and areas with high infant thyroid equivalent doses estimated by SPEEDI. The Local NERHQ conducted investigation on the exposure of infant thyroid glands to radiation in Iwaki City March 26-27, in Kawamata Town March 28-30, and in Iitate Village March 30. The investigation found no one with the exposure beyond the screening level (0.2μSv/h) shown by the NSC.

[Governmental Final Report] Chapter IV 2

1. Insufficient initial exposure evaluation

During the accident, radioactive materials were emitted directly into the environment, resulting in the evacuation of approximately 150,000 residents. Radioactive iodine, radioactive cesium and other radioactive materials emitted from the Fukushima Daiichi Nuclear Power Plant as radioactive plumes behaved differently depending on the weather conditions, including precipitation of rain and snow. As a result, radioactive materials were deposited in the soil northwest of the Fukushima plant. In order to take measures to reduce the effect of these radioactive materials on the health of the residents, it was important for the NERHQ and Fukushima Prefecture to ascertain not only the long-term exposure of the residents but also the initial exposure situation.

The Fukushima Prefecture radiation emergency medical care manual required that the evacuation route and exposure dose be recorded at the time of screening. But in practice, the large number of evacuees that were being handled hampered recordkeeping, and the investigation into the initial exposure levels of the residents was not handled sufficiently.

The effective half-life of iodine 131 is about five to seven days in infants and children, so if early measurements are not taken it is impossible to grasp the actual situation. Based on experience in the Chernobyl nuclear accident, it is known that an emergency exposure evaluation in the initial period is important with respect to gauging internal exposure to radioactive iodine.

There are two types of exposure—internal exposure and external exposure—but the external exposure of the residents in the initial period depends on the behavior of the radioactive plume and the actions of the people who are exposed. It is necessary to estimate the exposure levels of individual residents by taking into account the records of their actions. Fukushima Prefecture was

responsible for estimating external exposure levels; as part of the Fukushima Prefecture Health Management Survey, the prefecture conducted an External Exposure Dose Estimates Study over four months from March 11.

The Local Nuclear Emergency Response Headquarters (Local NERHQ) conducted some investigations into internal exposure by radioactive iodine. In response to a request from NSC, the Local NERHQ performed screening tests for thyroid gland exposure levels on 1,080 infants and children (from 0 years old to 15 years old) in Iwaki City, Kawamata-machi, and Iitate-mura from March 26 to March 30. From the results of these tests, the NSC of Japan reached the conclusion that there were no infants or children with a thyroid gland equivalent dose in excess of 100mSv.

The NSC of Japan has recognized that these tests were simple monitoring to check whether or not there were any infants or children whose internal exposure had been in excess of a screening level classified as 100mSv, and were therefore low precision tests. Among the test subjects were three children with internal exposure below the screening level, but with readings in excess of 30mSv. However, it appears that NERHQ did not wish to expand the investigation. With excuses such as "conducting a follow-up investigation would cause enormous unease among the test subjects, their families and the local communities," etc., NERHQ asked NSC for "advice to the effect that a follow-up investigation is not necessary" for these children. In the end, NSC issued advice in a form that reflected the wishes of NERHQ; it stated: "we should judge whether or not a final follow-up investigation should be implemented while continuing to monitor the situation at the nuclear plant." These were the last tests; NERHQ did not perform any further tests of the thyroid gland exposure levels of the children. Fukushima Prefecture also appealed to researchers who were performing their own examinations of the thyroid gland exposure of the residents at that time to stop measuring internal exposure levels.

Neither the NERHQ nor Fukushima Prefecture performed sufficient tests of internal exposure to radioactive iodine, so the actual initial internal exposure of the residents to radioactive iodine is unclear. Although the Prefecture Health Survey will perform thyroid gland tests on the residents of the prefecture that were under 18 years old at the time of the accident for their entire lives, the fact that the initial exposure levels are unknown is a weakness in these evaluations.

[National Diet Report] Chapter 4, 4.3

The following isssues can be raised in association with estimation of thyroid equivalent dose of radioactive iodine by simple measurement.

Radiation exposure of residents – estimation of thyroid equivalent dose of radioactive iodine by simple measurement

- Screening tests for thyroid gland exposure levels on 1,080 infants and children were carried out in Iwaki City, Kawamata-machi, and Iitate-mura from 26 March to 30 March 2011; however, this involved low-precision tests and no further tests of the thyroid gland exposure levels of the children were carried out.

・Internal dose assessment by whole body counter (WBC)

Descriptions about internal dose assessment by whole body counter (WBC) are given in **[National Diet Report]** in the following way.

3. Prefectural People's Health Management Survey does not include internal exposure

screening

The health impacts of radiation must be pursued and examined over the long term. On May 27, 2011, Fukushima Prefecture established the Fukushima Prefecture Health Management Survey Committee. The purpose was to relieve prefectural residents' concerns related to the nuclear power plant accident and to ensure their safety and comfort in the long term through a health monitoring scheme. The health management surveys comprise a basic survey of all prefectural residents, and also a more detailed survey of children aged 18 or younger, pregnant women, and others for whom additional surveying is deemed necessary. For the basic survey, questionnaires are sent to individual residents and are used to estimate external radiation exposure during the period for which air doses were highest. The detailed survey includes four distinct parts: 1) a thyroid examination for children aged 18 and younger; 2) a health survey with an additional comprehensive blood test; 3) a survey for pregnant women; and 4) a survey on mental health and living habits.

However, none of the surveys include a screening for internal exposure that takes into account the long-term impact of radioactive cesium. While there are surveys of residents conducted using WBCs by the municipalities and hospitals, there is no national or prefectural-level plan to collect that data and implement long-term impact surveys.

a. Prefectural health surveys and internal exposure surveys using WBCs

A WBC internal exposure screening was implemented as a preliminary survey prior to the prefecture health monitoring surveys; however, according to interviews with individuals related to the Fukushima Prefecture Health Management Survey Committee, the decision was taken to no longer include WBC screenings in the prefecture health management surveys because the level of internal exposure was very low and it was not likely that levels would rise as a result of food consumption. Ten months following the accident, approximately 40,000 of Fukushima's 2,000,000 residents had received internal exposure examinations. One-third of those examinations were conducted by hospitals independently of the prefectural survey.

(Omission)

c. Inadequate internal exposure monitoring

If, as a result of internal exposure due to consumption of food products, an increase in the Japanese residents' internal exposure levels did occur, it would be impossible to confirm the levels and implement countermeasures because surveys for internal exposure levels are not being conducted. At present, neither the national nor prefectural governments have plans to implement internal exposure level screenings. While internal exposure surveying using WBCs is not included in the prefectural health monitoring surveys, there is strong demand for this surveying by the residents, as reflected by the fact that WBCs have been obtained and measurements are conducted at municipal offices, private hospitals, and private sector organizations. These data are not being compiled in one database, but rather stored separately by individual municipal governments and hospitals.

The prefectural government has requested hospitals that conduct WBC screenings free of charge for residents to provide the WBC measurement data that is collected. This request, however, has been rejected. The hospitals cited the necessity for patient permission as a prerequisite for providing the data.

There is thus no policy in place by the national or prefectural governments for monitoring and utilizing internal exposure data, and as there are no measures in place for implementing WBC screenings, there is no collaboration or cooperation between hospitals and municipalities that conduct WBC examinations on their own.

[National Diet Report] Chapter 4, 4.3

The following isssues can be raised in association with internal dose assessment by whole body counter (WBC).

Radiation exposure of residents – internal dose assessment using whole body counter (WBC) – investigation system

- As part of the Fukushima Prefecture Health Management Survey started in June 2011, individual doses for external exposure were investigated as the External Dose Estimation based on the behavior records in the Basic Survey. However, investigation of the dose for internal exposure using the WBC was not carried out in the Basic Survey. For this reason, the WBC measurement results are individually kept in each municipality or hospital since these data are a form of personal information that is unavailable for use for other objectives without permission. The WBC measurement for internal exposure was not addressed in the nuclear emergency preparedness plan, which was a main cause of the delay in conducting the WBC measurement.

Radiation exposure of residents – internal dose assessment using whole body counter (WBC) – measurement method

- Since individual dose assessment for internal exposure using the WBC highly collected the needs of residents, the WBCs were individually set up by municipalities, hospitals, and nongovernmental organizations, in addition to direct management by the Fukushima prefectural government. Therefore, the dose assessment was carried out by nonunified methods without standardization.

・External dose assessment by personal dosimeters

Descriptions about external dose assessment using personal dosimeters are given in **[Nuclear Regulation Authority (NRA) HP]**, **[Fukushima Prefecture HP]** and **[Fukushima city HP]** in the following way.

Dosimetry using personal dosimeter

Support project to urgently prepare personal dosimeters

Subsidized project carried out by Fukushima prefecture since 2011 fiscal year to let residents confirm their individual dose due to external exposure and correlated with health control.

- Support for the preparation of personal dosimeters and survey meters to be provided by city, town or village for residents (below 15 years of age and pregnant women).
- The percentage of support is 100%.

Number of supported cities, towns and villages

	平成23年度	平成24年度予定
バッジ式線量計	47*	31
電子式線量計	50	50

* Preparation of personal dosimeters using this support project was carried out by 58

cities, towns and villages in 59 cities, towns and villages in Fukushima prefecture in 2011 fiscal year. (Remaining Kawamata town was out of the count because Kinki University had cooperated with the town to prepare badge-type personal dosimeters)

[Nuclear Reguration Authority HP (30 Nov. 2012)]

Radiation dose obtained at the present stage

2 Personal dosimeters

(1) Refer to inquired data (22 cities, towns and villages) to advisory group

Median: below 1 mSv/year

When the radiation dose is higher than the average value of the measured group, the background reason was confirmed and measurement was continued.

(2) Fukushima city (from homepage and newspaper)

Median: 0.8 mSv/year (0.2 mSv per 3 month measurements: Fukushima city)

There is a case higher than 10 mSv/year due to inappropriate use of the dosimeter.

Overview of measurement resultsobtained using personal dosimeters analyzed by advisory group (FY 2011)

市町村名	測定期間	測定人数	最低値 (mSv)	最高値 (mSv)	中央値 (mSv)	最高値 年間換算 (mSv)	備　考
A	1か月	101名	0.4～0.6未満	6.8　※	0.8～1.0未満	6.8　※	全て年間換算値で提示。 ※最高値は誤動作（継続測定にて確認） 電子式・バックグラウンドを含む
B	1か月	1218名	0	0.28	－	3.36※	※（1か月）×12
C	約1か月※	92名	0.04	0.22	0.06	2.56※	※測定時間から線量率を計算 電子式・バックグラウンドを含む
D	71日間	694名	0.01未満	0.06	0.01	0.31※	※（71日）×365/71
E	81日間	5156名	×（0.00～0.04）	1.7	0.2	7.66※	※（81日）×365/81
F	83日間	1488名	×（0.00～0.04）	0.3	0.1	1.32※	※（83日）×365/83
G	3か月	107人	0.01未満	0.10	0.04	0.40※	※（3か月）×4
H	3か月	592名	0～0.04	0.31	0.05	1.24※	※（3か月）×4
I	3か月	922名	0.01未満	0.20	0.05	0.8※	※（3か月）×4
A	3か月	942名	0.05	0.54	0.09	2.16※	※（3か月）×4
B	3か月	1157名	×（0.00～0.04）	0.18	×（0.00～0.04）	0.72※	※（3か月）×4
J	約3か月	1017名	×（0.00～0.04）	0.6	0.1	2.4※	※（約3か月）×4 玄関先雨樋近辺放置
K	約3か月	1081名	0.12	0.50	－	1.77※	※積算線量から1日当たりの線量を計算し算出。バックグラウンドを含む

市町村名	測定期間	測定人数	最低値 (mSv)	最高値 (mSv)	中央値 (mSv)	最高値 年間換算 (mSv)	備　考
L	約 3 か月	1765 名	0.1 未満	0.4	0.1 以上 0.2 未満	1.6※	※（約 3 か月）×4
L	1～3 か月	292 名	0.50	1.94	0.7 以上 0.8 未満	1.94	全て年間換算値で提示。 電子式・バックグラウンドを含む
M	92 日	31235 名	0.01 未満	11.75	0.09～0.12	46.6※	※（92 日）×365/92 レントゲン検査実施
N	103 日間	4559 名	0.02	1.51	0.10 以上 0.19 未満	5.35※	※（103 日）×365/103 海外旅行有り
O	4 か月	1061 名	0.0	1.0	0.2	3.0※	※（4 か月）×3
P	4 か月	1089 名	0.0	0.8	0.1	2.4※	※（4 か月）×3
Q	5 か月	511 名	0～0.04	0.45	0.10～0.14	1.08※	※（5 か月）×12/5
R	5 か月	860 名	0	0.8	0.2	1.92※	※（約 5 か月）×12/5
S	5 か月	1687 名	－	－	－	1.50※	※年間最高値のみ
T	約 5 か月	807 名	－	0.51	－	1.22※	※（約 5 か月）×12/5
U	約 5 か月	1291 名	0.52	3.89	－	3.89	全て年間換算値で提示。 バックグラウンドを含む
V	約 5 か月	10676 名	0.03	2.4	0.20～0.29	5.78※	※（約 5 か月）×12/5 海外旅行有り

Note: This table was sorted by measurement period and number.
Median corresponds to measurement period, unless otherwise stated.
These data were obtained from the inquired data to advisory group by city, town and village and also there were indication by category.
When the measurement was performed twice and the first and the second data were not linked, the data were described in every measurement case.
This table was separately described when the measurement tools were different even if the measurement was done for the same period by the same city, town and village.

[Fukushima Prefecture HP (26 Apr. 2012)]

Measurement results of personal dose meters (glass badge)

Fukushima city provided personal dose meters (glass badge) to children and pregnant women and implemented a measurement of accumulated dose for 3 months from September to November, and measurement results of the personal dose meters (glass badge) are notified.

Furthermore, these data were reviewed by the Fukushima city health care examination committee that consists of doctors in Fukushima city medical association and Fukushima city radioactivity advisers.

Target of the measurements

(1) Infants and students below junior high school who live in Fukushima city
(2) Pregnant women who live in Fukushima city
* Both (1) and (2) includes evacuees in Fukushima city owing to the Great East Japan Earthquake and subsequent tsunami.

Period of the measurements

Measuremnts were carried out for 3 months (from 1 September to 30 November 2011), and results were analyzed for two separate periods.
1st measurement 1 to 30 September 2011
2nd measurement 1 October to 30 November 2011

Measurement results

1. Number of measurement targets, who were provided dosimeters and from whom data were collected.

対象者数	1回目配布数	1回目回収数	1回目回収率	2回目配布数	2回目回収数	2回目回収率	3か月間測定者数
46,303	38,182	37,671	98.7%	38,153	36,804	96.5%	36,767

* The first collected number and ratio are as of 31 October 2011.

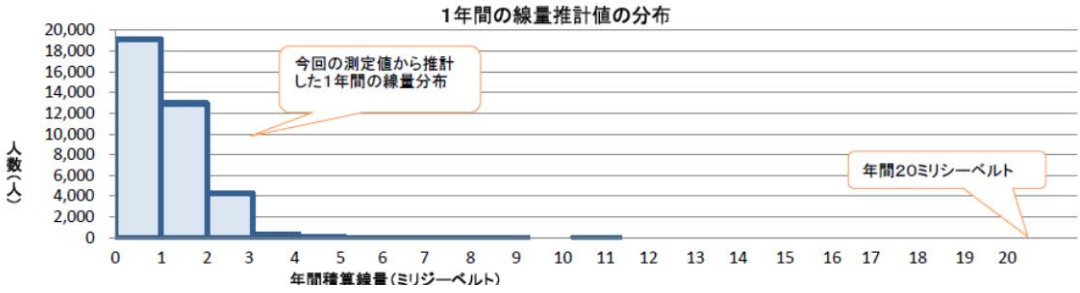
* The second collected number and ratio are as of 26 December 2011.
* Measument number for three months are the data as of 26 December 2011.

2. Number and ratio of measurement for three months

		人数（人）	割合（%）
3か月間測定者数		36,767	100%
内訳 累積値（ミリシーベルト）	0．1未満(X)	3,313	9.011%
	0．1以上～0．5未満	28,763	78.230%
	0．5以上～1．0未満	4,581	12.460%
	1．0以上～1．5未満	93	0.253%
	1．5以上～2．0未満	10	0.027%
	2．0以上～2．5未満	2	0.005%
	2．5以上～3．0未満	5	0.014%

* The maximum dose is 2.7 mSv
* The backgrounds of the glass badge used by people who received more than 2.0 mSv for three months
  - ・Misplacement of the glass badge outdoor
  - ・Misplacement of the glass badge on bicycle
  - ・X-ray inspection of baggage in airport

3. Estimation of annual dose



4. Views from the Fukushima city health care examination committee

These data were reviewed at the Fukushima city health care examination committee meeting held on 4 January 2012. The following views from the committee members were provided; “From the present results, there is little possibility of radiation leading to an increase in cancer incidence”.

[Fukushima City HP (17 Jan. 2012)]

The following isssues can be raised in association with external dose assessment using personal dosimeters.

Radiation exposure of residents – external dose assessment using personal dosimeters

- Since dose assessment was carried out by each municipality by lending personal dosimeters in response to the needs of residents, individual dose data for external exposure are kept in the respective municipality because these data are a form of personal information that is unavailable for use for other objectives without permission.

・External dose estimation on the basis of behavior survey

Descriptions about external dose estimation on the basis of behavior survey are given in **[Governmental Interim Report]**, **[Governmental Final Report]**, **[National Diet Report]** and **[Nongovernmental Report]** in the following way.

d. Medical checks conducted for the citizens of Fukushima Prefecture

On May 19, the Fukushima prefectural government established the Fukushima Prefecture Health Monitoring Survey Research Committee to discuss how to conduct medical checks for the citizens of Fukushima Prefecture. In response to those committee discussions, on June 30, the Fukushima prefectural government began delivering sets of inquiry forms, which dealt mainly with dietary and behavioral records from March 11, to individual evacuees from Namie-town, Iitate-village and Yamakiya district of Kawamata-town, who were subjects participating in the survey. The same set of inquiry forms was delivered to all remaining citizens of the prefecture on and after August 26. The survey included forms for entering basic survey details as well as medical checkup, Q&A survey, and thyroid gland examination results. The results of the survey are to be managed and maintained in a database on a long-term basis.

[Governmental Interim Report] Chapter V 4

d. Medical checks conducted for the citizens of Fukushima Prefecture

As described in Chapter V 4. (5) d. of the Interim Report, the Fukushima prefectural government has been conducting health surveys on the residents in the prefecture.

The Fukushima prefectural government, based on the basic surveys in these health surveys, estimated the external exposure doses of a total of 25,667 people (including 1,358 radiation workers) for four months after the nuclear accident and announced the estimation results on June 12, 2012. Of those surveyed, people with the external exposure dose of 10mSv or higher numbered 147 (including 48 radiation workers). The maximum value of external exposure dose for people other than those who had experiences in engaging in radiation-related work was 25.1mSv.

[Governmental Final Report] Chapter IV 4

As noted above, screening examinations only indicate the possibility of external or internal exposure. From this data alone, it is impossible to know the exact number of people who suffered from external or internal exposure or to get further details about the dose to which they were exposed. Because it is impossible to specify an accurate exposure dose for individuals, the external exposure dose was estimated in Fukushima Prefecture's "Prefectural People's Health Management Survey" (Ken-min Kenko Kanri Chosa), on the basis of each individual's activities.

This survey made estimates of the cumulative effective dose of external exposure based on individual's activities between March 11 and July 11, 2011, using an assessment system developed by the National Institute of Radiological Sciences (NIRS). The results for a number of regions have been announced.

Shown below are the estimated results for 14,412 persons, excluding nuclear plant related workers, from the Yamakiya district of Kawamata Town, Namie Town and Iitate Village, where the air dose rate was relatively high, resulting in their designation as regions subject to precursory examination (as of June 2012).

Table 4.1-3 Estimated cumulative effective dose of external exposure for 14,412 residents in three areas from March 11 to July 11, 2011

Results of estimated cumulative effective dose of external exposure for 14,412 residents excluding "Occupationally Exposed Persons"

Less than 1mSv	8,221	57.0%
1mSv to10mSv	6,092	42.3%
More than 10mSv	99	0.7%

[National Diet Report] Chapter 4, 4.1

From now on, how should we control radiation effects on residents for long-term period? For example, Fukushima prefecture decided to implement "Prefectural People's Health Management Survey" for the purpose of health control of residents in the future. According to a report on December provided by the committee, accumulated radiation doses of 1589 residents are given as follows: 998 (62.8%) for below 1 mSv, 1,547 (97.4%) for below 5 mSv, 1585 (99.7%) for below 10 mSv, and 4 for above 10mSv, and the maximum dose is 14.5 mSv (1 resident). However, this result is just an "estimation from behavior records using interview sheet". Number of collection was 370 thousands within about 2 millions of target residents. In the future, more accurate, rapid and expertized long-term survey implemented by national government would be needed.

[Nongovernmental Report] Part 1 Chapter 2 Section 4

The following isssues can be raised in association with external dose estimation on the basis of behavior survey.

Radiation exposure of residents – external dose estimation on the basis of behavior survey

- As part of the Fukushima Prefecture Health Management Survey started in June 2011, the individual dose for external exposure was investigated as the External Dose Estimation, using the behavior records obtained via sets of inquiry forms in the Basic Survey. However, the recovery ratio of inquiry forms was only 18% in December 2011. (As of 31 January 2013, the recovery ratio for the whole area of the prefecture was 23.2% and that for the preceding investigation area, Yamakiya district of Kawamata Town, Namie Town, and Iitate Village was 56.7%)

(c) Radiation exposure of plant recovery workers

- Reservations of personal dosimeters, WBCs and protective tools, and administration of stable iodine in emergency works

Descriptions about reservations of personal dosimeters, WBCs and protective tools, and administration of stable iodine in emergency works are given in **[Governmental Interim Report]**, **[Governmental Final Report]**, **[National Diet Report]** and **[TEPCO Report]** in the following way.

b. Organizational framework for radiation control after the nuclear accident

(a) Establishment of radiation controlled zones

After the nuclear accident at the Fukushima Dai-ichi NPS, radiation levels increased throughout the entire premises of the nuclear power station. However, TEPCO was not initially willing to redefine a controlled area as stipulated in its in-house safety regulations. On April 27, however, as

described in Section c (b) below, based on the fact that a female radiation worker received radiation dose greater than the allowed dose limit, NISA instructed TEPCO to validate its organizational framework for radiation control and implement measures to rectify this situation. In response to this, on May 2, TEPCO designated the entire premises of the Fukushima Dai-ichi NPS as a temporary and emergency radiation controlled zone to be controlled in the same manner as a radiation controlled zone. It was decided that the temporary and emergency controlled zone should be treated as a controlled zone stating that it would be marked with a sign showing that access to the designated area is restricted to those individuals who do not require access in order to perform their duties, other necessary signs would be installed, and that radiation workers must be equipped with a rental APD and other protective equipment.

(b) Registration as a radiation worker

At the Fukushima Dai-ichi NPS, from the date of the nuclear accident through to May 10, radiation workers were allowed to carry out their duties inside the temporary and emergency radiation controlled zone after receiving a brief 30-minute explanation about how to protect themselves from radiation and how to wear protective equipment. In addition, (although there is no legal obligation to do this) there was a delay in radiation workers getting registered as professional radiation workers with a radiation worker certificate provided by the Central Registration Center of Radiation Workers and so some radiation workers performed their duties without a radiation worker certificate.

(c) APD (alarm pocket dosimeter)

TEPCO had about 5,000 APDs installed at the entrance to the controlled zone of Units 1 to 6 and at the entrance to the centralized waste treatment facilities, but most of them were covered in water and damaged by the tsunami. Hence, as a temporary arrangement, it was decided to perform radiation control measures using about 320 APDs that had been kept in a Seismic Isolation Building. Sometime between March 12 and 13, 500 APDs (200 of them from the Fukushima Dai-ni NPS) were provided as aid supplies from Kashiwazaki-Kariwa Nuclear Power Station. Unfortunately, however, there was a lack of communication between the pickup window personnel that received the APDs and the health physics team that desperately needed them, and these APDs were simply stored, unused until April 1. Many workers left the Fukushima Dai-ichi NPS after the earthquake and initially very few remained to perform their duties. Gradually more and more joined them until there were not enough APDs and by March 15 not every worker was able to wear an APD. In response to this situation, Mr. Masao Yoshida, head of the Fukushima Dai-ichi NPS (hereinafter referred to as "site superintendent Yoshida") decided to let only the leaders of an operational group wear APDs on behalf of the entire group as long as the following conditions were met: (i) the assumed total radiation dose per job is not great (less than about 10mSv), (ii) air radiation dose rates at the work site are known, (iii) environmental dose rates gradient (difference between air radiation level rates in the same space) is not great, and (iv) all members of an operational group always together at a work site. This decision was made based on the following assessment: the provisory clause, which states that "however, if it is considerably difficult to perform the said measurement with the said radiation measuring instrument, the said dose from external exposure may be computed using the measured dose equivalent rate, and if it is also considerably difficult to compute it, then the said value may be obtained through calculations," of Article 8, Paragraph 3 of Ionization Rules stipulating that "the measurement of radiation dose from external exposure according to Article 1 shall be performed by wearing radiation measuring instrument on parts of the body specified in the following items", was applicable to this case. As described above, a sufficient number of APDs was finally obtained on April 1. TEPCO decided to have all of its workers wear APDs from the same day and to not allow them to work if there were not enough APDs.

(d) Managing access to and from a controlled area

After the nuclear accident, access to and from the controlled area of the management system was initially rendered inoperative for calculating the radiation dose of individual radiation workers. TEPCO decided to manually calculate the radiation dose of individual radiation workers using

APDs. On April 14, TEPCO had five simplified instruments installed in the Seismic Isolation Building for gaining access to and from the controlled area management system. At the same time, they introduced a radiation work permit with bar code patterns so that the names and radiation dose of individual workers could be automatically recorded.

[Governmental Interim Report] Chapter V 4

(c) APD (alarm pocket dosimeter)

TEPCO had about 5,000 APDs installed at the entrance of the controlled zone of Units 1 to 6 at the Fukushima Dai-ichi NPS and in the centralized waste treatment facilities, but most of them were covered with water and damaged by the tsunami. Hence, as a temporary arrangement, it was decided to perform radiation control measures for workers using about 320 APDs that had been kept in the Seismic Isolation Building.

The TEPCO Kashiwazaki-Kariwa Nuclear Power Station (hereinafter referred to as the "Kashiwazaki-Kariwa NPS"), which was aware of the status of the accident through information from TEPCO's television conference system and the communication with the Emergency Response Center health physics team at the Fukushima Dai-ichi NPS (hereinafter referred to as the "Fukushima Dai-ichi NPS health physics team"), sent 530 APDs, eight units of battery chargers for APDs (three units for 10 APDs and five units for 100 APDs) and an APD alarm setter as relief supplies to the Fukushima Dai-ichi NPS from March 11 to March 12. Of these suppliers, 30 APDs, three units of battery chargers (for 10 APDs) and an APD alarm setter arrived at the Fukushima Dai-ichi NPS on March 12 and were used from the same day. However, of the 500 APDs sent separately on March 12, though 300 APDs arrived at the Fukushima Dai-ichi NPS on the same day and 200 APDs on March 13, they were not used, as described later, as battery chargers compatible with these APDs had yet not arrived. Furthermore, as a member of the Fukushima Dai-ichi NPS health physics team, who knew that these APDs were kept unused, left the Fukushima Dai-ichi NPS by March 14, the 500 APDs remained unused and were kept at the Seismic Isolation Building of the Fukushima Dai-ichi NPS until the end of March. The five units of battery chargers (for 100 APDs), together with the 200 APDs mentioned above, were loaded on a truck heading for the Fukushima Dai-ni NPS on March 12. However, after they arrived at the Fukushima Dai-ni NPS on March 13, only the 200 APDs that could be transshipped immediately were delivered to the Fukushima Dai-ichi NPS, while the five units of battery chargers (for 100 APDs) mentioned above were kept in a warehouse of the Fukushima Dai-ni NPS.

The Fukushima Dai-ichi NPS health physics team initially thought some 350 APDs secured by March 12 would be sufficient as the number of workers outside the Seismic Isolation Building was not so large. However, as the number of workers increased later, the number of APDs ran short from around March 15.

In response to this situation, Mr. Masao Yoshida, head of the Fukushima Dai-ichi NPS (hereinafter referred to as "Site Superintendent Yoshida") decided to let only the leaders of an operational group wear APDs on behalf of the entire group as long as the following conditions were met: (i) the assumed total radiation dose per job is not great (less than about 10mSv), (ii) air radiation dose rates at the work site are known, (iii) environmental dose rates gradient (difference between air radiation dose rates in the same space) is not great, and (iv) all members of an operational group are always together at a work site. This decision was made based on the following assessment: the provisory clause, which states that "however, if it is considerably difficult to perform the said measurement with the said radiation measuring instrument, the said dose from external exposure may be computed using the measured dose equivalent, and if it is also considerably difficult to compute it, then the said value may be obtained through calculations," of Article 8, Paragraph 3 of Ionization Rules stipulating that "the measurement of radiation dose from external exposure according to Article 1 shall be performed by wearing radiation measuring instrument on parts of the body specified in the following items" was applicable to this case.

In parallel with the above, the Fukushima Dai-ichi NPS health physics team told the TEPCO Head Office that APDs were in short supply. Of APDs that were ordered in early 2010 and being delivered gradually, the TEPCO Head Office, around March 16, asked the supplier to frontload the

delivery of 400 APDs that were to be delivered in April 2011, and 100 of them were delivered to the Fukushima Dai-ichi NPS on March 17. The delivery brought the total number of APDs available at the Fukushima Dai-ichi NPS to 450, but the Fukushima Dai-ichi NPS continued with the practice of letting only the leaders of an operational group wear APDs on behalf of the entire group. The remaining 300 APDs were delivered on April 3.

On March 17, the TEPCO Head Office, through Chubu Electric Power Company, which was the managing company of the Federation of Electric Power Companies (FEPC) at the time, asked Shikoku Electric Power Company (hereinafter referred to as "Shikoku Electric Power") to provide APDs. In response to the request, Shikoku Electric Power sent out 450 APDs as well as five units of battery chargers (four for 100 APDs and one for 50 APDs) and two alarm setters. They were delivered to the J-Village stadium by around March 21. However, when TEPCO employees taking charge of management of equipment and materials at the J-Village stadium checked the equipment and materials delivered, they could not find the alarm setters and sent only the APDs and battery chargers to the Fukushima Dai-ichi NPS. Informed of the delivery, the head of the Fukushima Dai-ichi health physics team became aware of the absence of the alarm setters and the fact alarm setters at the Fukushima Dai-ichi NPS cannot be used for the APDs delivered by Shikoku Electric Power. However, the health physics team head sent back the ADPs and battery chargers to the J-Village stadium without asking the TEPCO Head Office to secure other alarm setters or giving thought to using the APDs without altering the alarm setup value, as the team head was of the view that there would be no problem in continuing with the practice of letting only the leaders of an operational group wear APDS on behalf of the entire group as done at the Fukushima Dai-ichi NPS at the time and was not aware of the need to secure more APDs as soon as possible. Thus, the APDs and other supplies delivered by Shikoku Electric Power were kept at the J-Village stadium without being used.

Subsequently, on March 31, the NISA, which became aware of the TEPCO practice of letting only the leaders of an operational group wear APDs, told TEPCO that the practice was not desirable and urged TEPCO to take all necessary steps for radiation control for its workers. Following this, on the same day, TEPCO decided to do away with the practice of letting only the leaders of an operational group wear APDs. Furthermore, informed by the Kashiwazaki-Kariwa NPS that became aware of this, TEPCO searched the Fukushima Dai-ichi NPS and the Fukushima Dai-ni NPS, and found the aforementioned 500 APDs at the Fukushima Dai-ichi NPS on March 31, and the aforementioned five units of battery chargers (for 100 APDs) at the Fukushima Dai-ni NPS on April 1. In addition, with the additional deliveries of 190 APDs and two units of battery chargers (one for 100 APDs and one for 50 APDs) form the Kashiwazaki-Kariwa NPS, a sufficient number of APDs and other equipment was secured on April 1 and the normal practice of having all workers wear APDs resumed the same day.

[Governmental Final Report] Chapter IV 4

4. Working conditions of the nuclear power plant workers

a. Management of external exposure dose

At the time of the accident, TEPCO had approximately 5,000 alarm pocket dosimeters (APD) at the premises of the Fukushima Daiichi plant. Before the accident, TEPCO distributed them to each worker in order to manage the external exposure dose received during their shifts. However, many were washed away in the tsunami, reducing the number of usable APDs to approximately 320. For work conducted around March 15, TEPCO could not provide enough APDs for all the plant workers, who went to either controlled areas or areas where an air dose equivalent to that in a controlled area was measured.

At times, TEPCO could not gauge the dose received by every worker, and in some cases, one APD would be loaned to a group. In principle, when loaning the APD to workers, the radiation manager on site would conduct interviews about the work each group would be performing, in order to determine whether to loan one APD to the group or to loan APDs to individuals.

One APD per group was used for the most part when outdoor work was conducted in places where air doses could be gauged through monitoring,

One APD per group was used in a similar way when air doses at the main control rooms of Units 1 and 2 and Units 3 and 4 increased due to the blasts resulting from, among other reasons, the hydrogen explosion at each of the units, which caused doors to break.

Our questionnaire showed that for 47 to 54 percent of the workers, APDs were distributed to them as a group. Up to the end of March, a similar percentage of workers reported having their own APD. A small percentage of workers, however, reported that no dosimeters had been distributed to them.

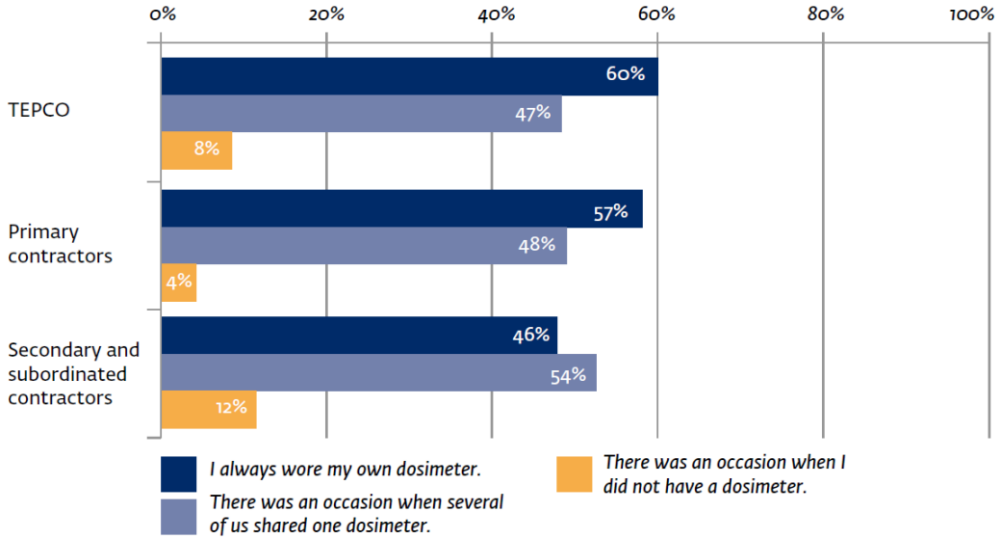


Fig. 4.4.5-2 Management of the dose received by nuclear power plant workers (multiple answers allowed)

Using APDs to manage the dose received by workers as a group does not necessarily constitute a violation of the law. But there was no system in place to ensure that radiation managers on site appropriately determined their distribution to individuals or groups. After the accident, radiation managers on site managed APD data by hand or with spreadsheets that show the inadequacies in the ways in which the exposure dose received by individual nuclear power plant workers were managed.

According to our questionnaire, around 30 percent of the nuclear power plant workers were never informed of their cumulative exposure dose.

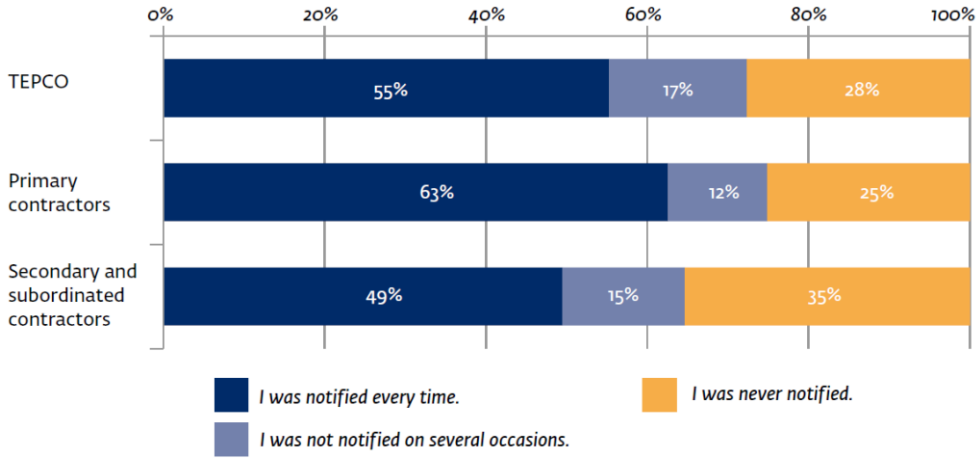


Fig. 4.4.5-3 Cumulative Exposure Dose

b. Management of the internal exposure dose

(i) Delay in the internal exposure measurements

Delays in WBC measurements caused delays in the identification of plant workers with high internal exposure doses. As a consequence of the accident, workers who received an exposure dose in excess of the legal limit included a TEPCO worker who received an internal exposure dose as high as 590mSv, highlighting the importance of internal exposure measurements.

The delays in the WBC internal exposure tests are thought to have been caused by two factors: a shortage of working WBCs at the time of the accident; and the timeconsuming nature of the test. Before the accident, four WBCs were installed at the Fukushima Daiichi Nuclear Power Plant, and were used to measure the internal exposure of plant workers every three months. However, the accident released a large quantity of radioactive particles, causing the concentration of radioactive material in the environment to increase, including the concentration in the air dose in the WBC room. The contaminated background level meant that the four WBCs could not be used. From March 22nd, TEPCO borrowed JAEA's vehicle-mounted WBCs, which were were installed at the Onahama Call Center, and internal exposure tests of the workers commenced. Thereafter, TEPCO borrowed WBCs from JAEA and other institutions as needed in an effort to increase the number of tested workers.

It also took time to assess the data. After a worker was measured using a WBC, if a high contamination was observed, personal decontamination was carried out to remove external exposure. The worker then needed to wait approximately two weeks to receive a test purely for only internal exposure. Workers had to receive tests every few weeks.

The root cause of the test delays is thought to be the inability to utilize the WBCs kept on the premises, due to the background air dose from the accident. The fact that TEPCO had not anticipated the release of radioactive material in an accident is, we believe, very problematic.

(ii) Background to the increases in internal exposure dose

One of the factors that contributed to increases in internal exposure doses was the lack of protective tools available to prevent the absorption of radioactive material. The full-face mask is the simplest and most essential equipment to prevent the internal exposure of workers to radiation. Full-face masks come as dust masks or charcoal masks. The two types differ in whether the mask filters radioactive iodine or not. Immediately following the accident, workers needed to wear the charcoal mask, which can absorb iodine, in order to prevent exposure to radioactive iodine.

Since the main control room was outside the controlled areas, it was not equipped with a sufficient number of full-face masks. Workers who worked at the main control room carried out emergency operations using the charcoal masks and dust masks that were available at the service building. However, the number of charcoal masks was limited. Furthermore, while a minimum number of masks were available, a sufficient number was not available for all plant workers. The short supply of charcoal masks attributable to TEPCO's insufficient preparations for a possible accident is another problem to tackle.

[National Diet Report] Chapter 4, 4.5

13.2 Post-Earthquake Radiation Control

(1) Radiation Control Overview

As a result of the tsunami, core damage, and reactor building explosions that occurred after the earthquake, it became pointless to try to differentiate between conventional controlled areas and other areas. Furthermore, APD and borrowed equipment (rechargers) located at the entry management points for controlled areas were inundated with water from the tsunami and rendered useless, and with the subsequent power loss, management systems used for managing entry and exit into controlled areas as usual, and aggregating exposure doses, etc., lost function.

Furthermore, with the loss of power stack radiation monitors and monitoring posts (MP) failed to function, so monitoring cars were deployed to start to measure (air dose rate, weather data, etc.) the environment, such as near the boundaries of the power station site. Two monitoring cars including a monitoring car provided by Kashiwazaki-Kariwa started to take measurements on March 12.

Furthermore, it was decided that all radiation control matters related to the power station would

be handled unilaterally by the ERC at the power station located in the seismic isolated building.

In the early morning hours of March 12, since radiation levels within the site had risen, it was decided that APD and protective clothing/protective equipment worn in accordance with the level of contamination that prior to the earthquake had only been worn in control areas, would be worn when leaving the seismic isolated building to engage in work.

The large-scale release of radioactive materials and the reactor building explosions led to not only contamination by radioactive materials of the entire site, but also contamination inside the seismic isolated building. Contamination of the entire site led to an increase in background radiation levels, making it difficult to evaluate internal exposure using the WBC located within the facility.

In dealing with the accident a base of operations separate from the seismic isolated building became necessary, so the J Village soccer practice facility located approximately 20km to the south of the Fukushima Daiichi NPS was selected for this purpose. On March 17, J Village became the base of operations for training workers engaged in emergency work, donning protective equipment and lending out dosimeters when engaging in work within the Fukushima Daiichi NPS without going through the seismic isolated building. As recovery work went into full force, and J Village became home to many workers and functioned effectively as a base of operations for filling out the required paperwork for receiving new workers to work inside the power station facility amidst the limited space within the seismic isolated building. Furthermore, a mobile WBC used to evaluate the internal exposure of workers engaged in emergency work was lent by the Japan Atomic Energy Agency (JAEA), so measurements could be taken at the Onahama Coal Center, etc.

(Omission)

(3) Condition of the Seismic Isolated Building and Radiation Level Reduction Countermeasures

Many people gathered in the seismic isolated building, which was the base of operations for handling the Fukushima Daiichi NPS accident, but the seismic isolated building environment worsened along with the surrounding environment. The efforts that were made to improve these conditions and the environment are discussed below.

There is only one entry/exit to the seismic isolated building and it is used by people as well as for loading and unloading. It has double-entry doors with one door closing before the other opens, so that outside air is not blown directly inside. This space between doors is where workers remove protective equipment and workers and items being brought inside are checked for contamination and decontaminated right inside the seismic isolated building. The double-door entry to the seismic isolated building is managed in this way 24 hours a day as strictly as possible through such measures as decontaminating and curing anything that exceeds background radiation levels even if 4Bq/cm^2 of normal contamination cannot be detected. However, as a result of the release of radioactive materials and the entry (double-door entry) being bent by the explosive blast, outside air found its way inside and radioactive concentration levels inside the seismic isolated building increased. As a result, a female TEPCO employee was exposed to a dose that exceeds legal limits.

Furthermore, during work conducted in the early morning of March 12 approximately 30 workers that had returned to the seismic isolated building were confirmed to be contaminated. The workers were temporarily isolated in a conference room since no policy had been predetermined in regard to screening levels during a nuclear disaster and also to prevent the spread of contamination, after which they were moved to Kawauchi Village, a place where background levels were lower, in order to take more accurate readings, however, background levels at Kawauchi Village had already risen so measurements were abandoned and the workers returned to the seismic isolation building.

Since there were many workers engaged in recovery work who were sleeping in the seismic isolated building in order to handle the expansive amount of work required following the accident, it became necessary to reduce exposure doses during their stay. Therefore, in addition to the existing charcoal filter ventilation equipment, countermeasures were gradually implemented, such as setting up localized exhaust fans with charcoal filters, erecting a temporary house at the entrance to prevent carrying in contamination, replacing OA floor mats (easily adhering radioactive material and hard to decontaminate) with tile that is easy to decontaminate, using sheets for curing, and

shielding windows with lead in order to reduce dose rates. As a result of these countermeasures, the air dose rate inside the seismic isolation building gradually decreased.

Furthermore, as with the seismic isolated building, charcoal filter exhaust fans were set up (Unit 1 to 6 MCRs: from April 4, 2011), survey areas for preventing the carrying in of contamination when entering and exiting, and monitoring (Unit 5 and 6 MCR where personnel were stationed at all times: from March 30, 2011) was performed in the MCRs where workers resided for long periods following the accident in order to monitor reactor instruments.

In addition, efforts were made to procure radiation control materials from the field and anew, since these materials were lacking due to the large number of workers that had assembled to engage in emergency work in an effort to contain the accident as quickly as possible.

[Tepco Report] Chapter 13 Section 2

(3) Iodine Tablet Dosing Status

Based on the advice of the Headquarters' industrial physicians on March 13 the General Manager at the ERC at the power station (Site Superintendent) ordered the medical team leader to make an internal announcement for the dosing of iodine tablets. Notices about iodine tablets distribution were put up within the complex without exception.

For the first few days after the commencement of iodine tablet distribution, the medical team gave instructions about dosing during the morning and evening power station ERC meetings, and thereafter, information about dosing methods was disseminated within the seismic isolated building in the same manner as changes were made. (On March 20, dosing was changed to one tablet after the second day of dosing. On April 10, it was decided that continuous dosing would continue until the 14. In the case of intermittent dosing the change was made that two tablets should be taken on the first day of dosing.)

Guidelines for dosing stated that all workers under 40, and those workers over 40 who desired so, should be dosed if engaging in disaster work where the predicted thyroid gland equivalent dose radiation level from radioactive iodine was 100mSv.

Iodine tablets were provided for approximately 7 months from March 13 through October 12, and the scope of provision was shrunk down on August 2 to some workers in designated buildings and then completely halted on November 21. Approximately 2000 workers, including contractors and TEPCO employees, were dosed, and approximately 17,500 tablets were provided with about 75% receiving less than 10 tablets per person, and at most 87.

Workers that took more than 20 iodine tablets or that continually dosed for more than 14 days were given medical examinations (approximately 230 exams given), and no abnormalities were seen. There were 178 workers that showed thyroid gland deposited equivalent doses of over 100mSv, and 25 workers under the age of 40 did not take iodine tablets. During the accident it was extremely difficult to take suitable protective action in regard to radiation control, and the fact that, even though information about iodine tablet dosing was disseminated, ultimately there were workers that did not take the tablets, which is a point that requires examination.

Thoroughly disseminating information in advance in the form of manuals and deciding on dissemination methods to be employed during accidents in addition to providing regular education in regard to precautions and usage guidelines regarding iodine tablet dosing and the need for it would be effective for increasing awareness about iodine tablet dosing in the event that iodine tablet dosing becomes necessary.

[Tepco Report] Chapter 13 Section 3

・Measuments and assessments of personal dose in emergency work

Descriptions about reservations of personal dosimeters, WBCs and protective tools, and administration of stable iodine in emergency works are given in **[Governmental Interim Report]**, **[National Diet Report]** and **[TEPCO Report]** in

the following way.

(2) Overview of people affected by radiation exposure
a. Exposure of radiation workers

Table II-2 Exposure of radiation workers

Exposure dose (mSv)	Number of persons	Proportion (%)
Above 250	6	0.04
200 (excl.) to 250 (incl.)	3	0.02
150 (excl.) to 200 (incl.)	20	0.12
100 (excl.) to 150 (incl.)	133	0.79
50 (excl.) to 100 (incl.)	588	3.48
20 (excl.) to 50 (incl.)	2,193	12.96
10 (excl.) to 20 (incl.)	2,633	15.57
10 or less	11,340	67.04
Total	16,916	

(The information about the number of persons is as reportedby TEPCO. The information is as of September 30.)

In the period between March 11 (beginning of the accident) and the end of September, more than 16,900 persons were engaged in emergency work activities.

The legal limit on the maximum dose that is incurred on a worker while being engaged in emergency work activities had been 100 mSv. However, on March 14, a decision was made to permit 250 mSv as the maximum dose for a worker during engagement in particularly demanding work activities conducted in response to the Fukushima nuclear accidents.

Six workers have exceeded this dose limit of 250 mSv during engagement in work activities conducted in response to the Fukushima nuclear accidents.

[Governmental Interim Report] Chapter II 4

c. Occurrence of exposed subjects and their countermeasures
(a) Subjects exposed to contaminated water from the Unit 3 turbine building

On March 24, three workers from a TEPCO partner company (male staff member A in his 30s, male staff member B in his 20s, and male staff member C in his 30s), who were installing electric cables under the surface of the basement floor of the Unit 3 turbine building, were exposed to high radiation dose while working immersed in contaminated water. In terms of radiation dose (external exposure), staff member A received 180.1mSv, staff member B received 179.34mSv and staff member C received 173mSv before they had finished working.

On March 24, these three staff members were informed that the air radiation dose rate at the worksite in the basement of the Unit 3 turbine building was about 2mSv/h on the previous day, March 23, before they walked down to their work site. They put on Tyvek protective suits and charcoal filter masks and also carried an APD with them. Additionally, staff members A and B put on low quarter shoes and staff member C wore high boots. Then they headed for the work site. Their APD was set to sound an alarm once each time the external radiation dose reached 4mSv and to sound a continuous alarm for three minutes to alert them that the external dose had reached 20mSv.

The three staff members found that there was a pool of water about 15cm deep covering the entire floor. They thought that it was probably only seawater and decided to start working. Their APD sounded before they started working. However, they thought that either their APD had sounded to tell them that its battery was flat or that their APD had malfunctioned due to the following reasons: they had been informed in advance that the air radiation dose rate at the work site was about 2mSv/h, and they had heard alarms before indicating an APD malfunction or as an

alert to charge a flat APD battery. Thus they proceeded with installing the electric cables. Later staff member A heard the APD sound continuously and wondered if the air radiation dose at the work site could be higher than expected. However, he thought it was important for them to complete their job to restore the power supply so they continued working.

After completing their job, it was discovered that these three staff members were all likely to have received high radiation dose. Staff members A and B in particular were at a high risk of radiation heat burns from their feet being soaked in radioactive water because they were wearing low quarter shoes thus subjecting them to continuous localized exposure. They visited Fukushima Medical University Hospital and the National Institute of Radiological Sciences to get cleaned up and have a checkup and get tested to measure their internal radiation doses. The localized radiation dose both staff members A and B received on their feet was 466mSv. Neither staff member A nor B suffered radiation heat burns on their feet.

In response to this incident, on March 25, TEPCO and its partner companies decided that if workers find something at their work sites contrary to what they are told in advance, they should report to the Station ERC to seek directions and that workers should leave their work sites immediately if they hear an APD sound its alarm. They gave their workers instructions to this effect.

(b) Subjects exposed to radiation exceeding the dose limit for female staff (5mSv for three months)

Four whole body counters (WBCs) that had been installed at the Fukushima Dai-ichi NPS were rendered inoperative due to a power blackout and an increase in air radiation dose rate. On March 22, TEPCO borrowed vehicle-mounted WBCs from JAEA and had them installed at Onahama. TEPCO started measuring the internal radiation dose of individual workers who were engaged in emergency work at the Fukushima Dai-ichi NPS using these WBCs. As a result, on April 27 and May 1, it was discovered that two female staff had received radiation dose exceeding the dose limit for women that is 5mSv for three months.

Female worker D, in her 50s, who was exposed to 17.55mSv of radiation, had mainly been engaged in firefighting related jobs at the fire station gatehouse near the Seismic Isolation Building excluding the period from March 11 to 23 when she had been temporarily evacuated to the Fukushima Dai-ni NPS. While she was working there, she refueled fire engines more than once outside the Seismic Isolation Building. Female worker D had been working at the gatehouse until she received the instruction of evacuation issued from the Fukushima Dai-ichi NPS on March 23.

Female staff member E, in her 40s, was exposed to 7.49mSv of radiation while she had been engaged in healthcare-related work as a crisis team member in the Seismic Isolation Building during the period from March 11 to 15. In the Seismic Isolation Building, she usually stayed in the emergency response control room on the second floor. Whenever someone was injured or sick, she went to the sick bay located near the entrance on the first floor to take care of him or her. She also worked near the entrance of the Seismic Isolation Building whenever emergency personnel arrived from outside. The doors of the entrance to the Seismic Isolation Building, which were bent and twisted at the time, were only temporarily sealed up. Hence, the air radiation dose rate on the first floor was higher than that on the second floor. In addition, female staff member E has not returned to the Fukushima Dai-ichi NPS since leaving there on March 15.

A common factor in both female staff members D and E, who were exposed to radiation, was that both of them had spent a long period of time near the entrance of the first floor of the Seismic Isolation Building, where the air radiation dose rate had been relatively high since the day of the nuclear accident. One factor specific to female staff member D was that she was engaged in refueling operations several times outside the Seismic Isolation Building.

On May 2, TEPCO summarized the causes of these radiation exposure incidents in which its staff received radiation dose beyond allowable dose limits and established measures to prevent similar incidents in the future and reported their findings to NISA.

This report describes the causes of these incidents as follows: after the nuclear accident, access to and from the Seismic Isolation Building was not properly controlled initially, the double-entry doors to the Seismic Isolation Building were not airtight and the doors to the Seismic Isolation Building were bent and twisted by the hydrogen explosions in Units 1 and 3. TEPCO concluded that

these factors resulted in female staff members D and E inhaling radioactive materials. Based on this conclusion, TEPCO implemented measures to prevent similar incidents in the future as follows: (i) on and after March 23, the Fukushima Dai-ichi NPS shall be managed and controlled without female workers, and (ii) the concentration of radioactive materials in the air shall be reduced in the Seismic Isolation Building by installing a local ventilation machine. In addition, TEPCO decided to implement the following additional measures for the future: (i) the entire premises of the Fukushima Dai-ichi NPS shall be treated as a controlled zone, (ii) radiation workers shall wear proper protective equipment to match their working environments, (iii) a system shall be implemented to control exposure, (iv) internal exposure doses for individual workers shall be measured more often (once a month when incidents have occurred and once every three months during normal times), (v) individual radiation workers shall be tested to measure internal radiation dose if the external radiation dose they have received exceeds 100mSv, and (vi) they shall not be allowed to work at the Fukushima Dai-ichi NPS if the external radiation dose they have received exceeds 200mSv. TEPCO reported these findings to NISA.

(c) Subjects exposed to radiation exceeding the dose limit for urgent emergency work (250mSv)

Subsequently, it was discovered that, on June 10 two workers (male staff member F in his 30s and male staff member G in his 40s), on June 20 1 worker (male staff member H in his 50s), and on July 7 three workers (male staff members I, J, and K in their 20s) had been exposed to radiation over 250mSv of the radiation dose limit, which was newly mandated by law.

Male staff members F, G, and H kept watch in the main control room of Units 3 and 4 during the period from March 11 to the evening of March 13 and subsequently they were engaged in their work several times. The exposure dose that these three staff members received were as follows: staff member F received 678.08mSv (88.08mSv of external dose and 590mSv of internal dose), G received 643.07mSv (103.07mSv of external dose and 540mSv of internal dose) and H received 352.08mSv (110.27mSv of external dose and 241.81mSv of internal dose).

Staff members F and G were engaged in collecting plant data in the main control room. Staff member H was the leader of additional staff in the same room. After the earthquake, the air radiation dose rate increased in the main control room of Units 3 and 4. Staff member H instructed the other staff in the room to wear masks. Unfortunately, there were not enough charcoal filter masks, which can screen out volatile iodine, for each staff member in the room. Some staff in the main control room wore charcoal filter masks and others wore dust filter masks, which cannot screen out volatile iodine, until charcoal filter masks were delivered from the Seismic Isolation Building in the evening of March 12. Staff members F, G, and H wore dust filter masks until the charcoal filter masks were delivered from the Seismic Isolation Building in the evening of March 12. In the control room, individual staff members were in charge of specific panels and were engaged in checking their respective panels on a continual basis. Staff members F and G spent most of their time checking the meters nearest the emergency doors, which were bent and twisted by the blast of the explosion. On the evening of March 13, these three staff members were replaced with backup members and then moved to the Seismic Isolation Building. At dawn on March 15, they were instructed to evacuate to the Fukushima Dai-ni NPS. Subsequently when they moved to the Seismic Isolation Building of the Fukushima Dai-ni NPS, they were grouped into teams to collect data in the same rooms in regular shifts for intervals of several hours. Additionally, staff member F was engaged in vent operations with two other staff members on March 13. Staff member G was engaged in refueling operations with two other staff members near Unit 1 on March 12. Staff member H had not been engaged in any outdoor operations until he moved to the Seismic Isolation Building. From March 14, he was engaged in refueling operations or checking fire extinguishing pumps at his work site. In addition, these three staff members had not taken stable iodine tablets until they moved to the Seismic Isolation Building on the evening of March 13. Additionally, staff member F had occasionally smoked cigarettes before the explosion in Unit 1 on March 12. Additionally, staff members F and H wore glasses.

Further, three staff members, I, J, and K, had been engaged in both restoring meters to their former state in the main control rooms of Units 1 and 2, and securing electric power supply outdoors, staying mainly in the Seismic Isolation Building since the earthquake. The radiation dose

that these three staff members received was as follows: staff member I received 308.93mSv (49.23mSv of external dose and 259.70mSv of internal dose), staff member J received 475.50mSv (42.40mSv of external dose and 433.10mSv of internal dose) and staff member K received 359.29mSv (31.39mSv of external dose and 327.90mSv of internal dose).

Early in the morning of March 12, the main control room shift supervisors of Units 1 and 2 instructed the staff in the rooms to wear masks. Staff member K wore a charcoal filter mask. Staff member J, most likely wore a dust filter mask, at least in the beginning. Staff member I joined the operations in the control room from that same day and from the very beginning wore a charcoal filter mask.

Subsequently, staff members I, J, and K were engaged in restoring meters to their former state in the main control rooms of Units 1 and 2 and in carrying meters to the control rooms wearing Tyvek protective suits and charcoal filter masks.

The emergency doors to and from the main control rooms of Units 1 and 2, which had been bent and twisted by the blast from the explosion in Unit 1, were only temporarily sealed up with vinyl sheets. Meters on the side of Unit 1 were located in a stream of air flowing from the emergency doors. Staff members I, J, and K were also engaged in restoring these meters to their previous state.

Additionally, there were sweets and drinks on the tables in the main control rooms of Units 1 and 2. These three staff members sometimes ate and drank at the table without wearing masks. Moreover, staff members J and K sometimes took their masks off and spent short periods of time without them or they loosened their masks because their breath fogged up their masks or their masks were too tight giving them a headache. Additionally, staff members I and J wore glasses.

A common factor in both staff members F and K receiving radiation exposure was that both of them were engaged in their duties near the emergency doors. Moreover, a common factor in staff members F, G, H, and J receiving radiation exposure was that they wore dust filter masks instead of charcoal filter masks while they were working.

TEPCO summarized the causes of radiation exposure for staff members F and G on June 17 and those of staff members H, I, J, and K on August 12, and reported these findings to NISA. The report describes the suspected causes of radiation exposure as: (i) it was difficult to wear masks properly and implement protective measures to control radiation even more effectively, (ii) its staff had no choice but to eat and drink in the main control room, (iii) the arms of glasses created a gap between the face and the mask, and (iv) its workers were engaged in their duties near the emergency doors, where the concentration of radioactive material was estimated to be extremely high. Based on these estimations, TEPCO decided to implement the following measures to prevent similar radiation exposure in the future: (i) information shall be shared more efficiently and equipment and material including masks shall be placed in their proper location, (ii) staff shall eat and/or drink only in designated areas, (iii) staff shall learn how to use and manage protective equipment for personal protection, and (iv) staff shall complete a pre-work survey.

(d) Health care provided for staff engaged in emergency works

TEPCO conducted further evaluations on the internal exposure its staff received. Subsequently, it was discovered that some employees who had been working on the premises of the Fukushima Dai-ichi NPS quit immediately after the nuclear accident and their whereabouts remained unknown. TEPCO collected and compiled this data and reported their findings to NISA. On July 7, NISA performed an on-site inspection to confirm that identification was not conducted properly, not even with public/official identification; that upon issuing a work permit the license was not delivered by hand; and that access to and from the nuclear power station was not managed exactly according to specific rules and regulations prescribed by nuclear power station authorities. On August 1, based on this on-site inspection, NISA reprimanded TEPCO and instructed TEPCO to provide a report summarizing how it would improve its system.

Prior to June 8, access to the Fukushima Dai-ichi NPS was possible even without a work permit. From June 8, access to the station required a work permit. However, a work permit was only issued if a partner company had confirmed the original public/official document with a photo attached. TEPCO issued copies of the work permit. Thus, TEPCO's work permit were handed out on a per partner company basis, not on a per person basis. TEPCO decided that from July 19 work permits

should be handed out directly to individual workers on a per person basis.

In addition, TEPCO asked its partner companies to perform aggregate data research. As a result, it was discovered that a total of 150 workers (11 workers in March, 66 workers in April and 73 workers in May), who previously belonged to TEPCO's partner companies and worked on the premises of the nuclear power station, were unable to be contacted. On August 8, TEPCO announced this. Subsequently, TEPCO and its partner companies fully examined all lists of their employees and established their contact details. As a result, as of October 31, only 16 of the 150 workers were unable to be contacted. In addition, as of this date, employees who had worked on the premises of the station after July were all contacted.

On May 17, the NERHQ developed a "Policy for Immediate Actions for the Assistance of Nuclear Sufferers" implementing long-term health management and a database capable of tracking the exposure radiation dose over the long-term for all workers engaged in emergency operations to help control the current situation. In response to this situation, on June 27, the MHLW established an "investigative commission for long-term health management of workers at TEPCO's Fukushima Dai-ichi NPS" lead by Mr. Yoshiharu Aizawa, vice-president of Kitasato University School of Medicine. The commission discussed how to conduct long-term health management of employees engaged in emergency work even after they left their current jobs including acquiring necessary information and conducting health checks. On September 26, the commission developed a report and issued an announcement to that effect.

[Governmental Interim Report] Chapter V 4

b. Workers at the nuclear power plant who had a cumulative internal and external exposure dose greater than 250mSv

The figures for the estimated cumulative effective dose of external exposure for residents in the advance survey described above are generally low. The workers at the nuclear power plant, however, were exposed to higher doses than the residents due to this accident.

During the period from March 2011 to April 2012, the number of workers engaged in efforts to bring the accident under control included 3,417 from TEPCO and 18,217 from other cooperating companies. Six TEPCO workers were exposed to a radiation dose in excess of 250mSv (cumulative dose of external and internal exposure), which is the upper dose limit for emergency responders stipulated in the Ordinance of the Ministry of Health, Labour and Welfare on special provisions to the Ordinance on Prevention of Ionizing Radiation Hazards. The number of workers who were exposed to a radiation dose in excess of 100mSv (cumulative dose of external and internal exposure), which is the figure considered to be the reference dose for incurring health damage, amounted to 146 persons among TEPCO workers and 21 persons among workers from other companies. The average exposure dose for workers from TEPCO and from other companies is, respectively, 24.77mSv (TEPCO) and 9.53mSv (other companies).

[National Diet Report] Chapter 4, 4.1

4.4.5 Exposure of nuclear power plant workers

On March 11, 2011, with the Fukushima Daiichi Nuclear Power Plant’s Unit 4 undergoing disassembly for inspection and Units 5 and 6 undergoing routine inspections, over 5,000 workers from partner companies were working at the nuclear power plant. Including TEPCO employees, a total of approximately 6,400 people were working at the site. Due to the emergency operations in the wake of the disaster, 167 of the nuclear power plant workers were exposed to radiation over 100mSv (total for internal and external exposures)—a dose that is thought to mean a significant cancer risk, assuming the LNT model. Among these, 6 workers were exposed to over 250mSv—the upper limit of the dose for workers in emergency operations, as set by the law—and 2 female workers were exposed to doses above the exposure limit for women. Between March 2011 and April 2012, the average exposure dose received by the workers of TEPCO and of partner companies was 24.77mSv and 9.53mSv, respectively.

The Commission conducted hearings and a questionnaire to gauge the radiological protection

TEPCO offered to nuclear power plant workers immediately after the accident at the Fukushima Daiichi Nuclear Power Plant. The questionnaire targeted approximately 5,500 nuclear power plant workers who were working on-site at the time of the accident. The purpose was to collect the opinions of the workers regarding the radiological protection measures taken by TEPCO immediately after the accident, including the management of dose levels. The hearings were conducted with a total of ten people, including TEPCO's radiological management personnel (head office and on-site), who manage the exposure of nuclear power plant workers, as well as the nuclear power plant workers, including five of the six people exposed to over 250mSv. The measures that TEPCO had taken for severe accidents were insufficient. As for the radiation protection measures TEPCO took for the nuclear power plant workers dealing with the accident, the fact that multiple workers were exposed to radiation in excess of the dose limit for the worker in emergency operations is a problem that should be noted. The delays in measuring the exposure doses of the workers which came about as a result of delays in taking internal exposure measurements, as well as TEPCO's insufficient management of the cumulative exposure doses of workers, are also problems that should be noted. Meanwhile, it is worth pointing out that at the Fukushima Daiichi plant, TEPCO workers and others took protective actions to reduce the exposure of the plant workers at their own discretion, including measuring the contamination level within the premises and creating a dose map.

In order to ensure the safety of residents, measures to counter the exposure of nuclear power plant workers are crucial; it is vital that the safety of the workers is ensured in dealing with an accident.

(Omission)

2. Situation of high exposure risk

TEPCO's legal responsibilities as an operator toward workers are provided for in the Ionization Rules. According to these rules, among other obligations, the operator is obligated to measure the external and internal exposure doses of radiation workers and to inform them of these results without delay. However, during the emergency immediately after the accident, there was a lack of radiological protection equipment, as, for example, dosimeters were washed away by the tsunami. TEPCO was unable to sufficiently manage the exposure dose received by the nuclear power plant workers and take protective action for them against radiation.

TEPCO explained that from before the accident, efforts were being made to reduce the dose received by nuclear power plant workers. However, according to hearings with TEPCO's radiation management personnel, dose management after the accident had been, in large part, left up to the judgment of the workers on site. In our survey of the workers who were at the site, many expressed dissatisfaction with this.

The following paragraphs describe specific cases of high exposure and violations of laws and ordinances.

a. Exposure due to contaminated water in the turbine building of Unit 3

On March 24, 2011, the feet of three workers from an affiliated company who were laying cables on floors 1 and B1 (basement) of the turbine building of Unit 3 of the Fukushima Daiichi plant came into contact with contaminated water, and received an external exposure dose of more than 170mSv. Two of the workers were wearing low shoes. As a consequence, radioactive material adhered to their feet, and the workers were at risk for beta burns. These workers were examined at the Fukushima Medical University Hospital and were hospitalized the following day at the Research Center Hospital for Heavy-Ion Radiotherapy at the National Institute of Radiological Sciences. The remaining worker was taken to the Fukushima Medical University Hospital and was hospitalized the following day at the Research Center Hospital. Their examinations revealed that the dose to their feet and their internal exposure did not reach a level that required treatment.

b. Female workers

Between March 11 and 23, 2011, a female worker in her fifties received a cumulative radiation dose of 19.38mSv due to work conducted on site, including the fueling of fire trucks and other vehicles. Another female worker in her forties, over a period of four days from March 11, 2011, received a cumulative radiation dose of 9.09mSv due to medical work conducted within the seismic isolation building. These doses significantly exceed the 5mSv three-month upper limit for female radiation workers, as set forth in Article 4, paragraph 2 of the Ionization Rules. After physicians examined the two female workers, the diagnosis was that their exposure had no effect on their health.

c. Workers exposed to radiation exceeding the 250mSv emergency dose limit

Between March 11 and May 23, 2011, a TEPCO employee in his thirties who worked at the main control room of Units 3 and 4 of Fukushima Daiichi Nuclear Power Plant collected data at the main control room, operated equipment of the power plant, and engaged in tasks outdoors, in the turbine building, and in the reactor building; in these processes, he received a cumulative radiation dose of 670.36mSv. Between March 11 and May 30, 2011, a TEPCO employee in his forties who worked at the main control room of Units 3 and 4 of the Fukushima plant conducted similar work and received a cumulative radiation dose of 639.73mSv.

During a one-month period from March 11, 2011, a TEPCO employee in his fifties who worked as a shift supervisor at the main control room of Units 3 and 4 giving instructions to operators at the main control room. While he did not enter the reactor building or the turbine building, he received a cumulative exposure dose of 346.27mSv. What the above three people share in common is that, during the three-day period from the disaster's occurrence on March 11 to March 13, they all worked at the main control room of Units 3 and 4, managing equipment within the power plant, for example, by making round trips as a team between the main control room and the turbine building/reactor building.

In addition, between March 11 and around early May 2011, three TEPCO workers, as members of the recovery team at the site, traveled to and from the seismic isolation building and the main control room of Units 1 and 2, taking instrument measurements and conducting recovery efforts. At the main control room, workers sometimes went to the reactor building and turbine building to connect the cables and transport batteries, among other tasks. In less than two months, the three workers received cumulative radiation doses in the range of 289.41 to 458.72mSv.

The exposure levels of these six workers significantly exceed the 250mSv upper limit for exposure for emergency operations, as set forth in the ministerial ordinance concerning the special provisions of Article 7, paragraph 2 of the Ionization Rules.

[National Diet Report] Chapter 4, 4.4.5

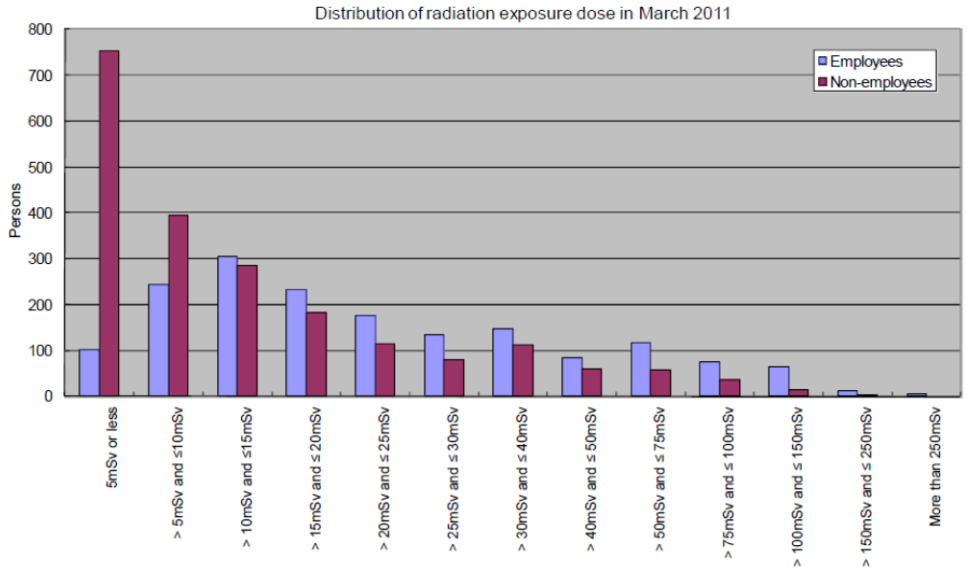
13.3 Handling and Circumstances Surrounding Worker Exposure

(1) Worker Exposure Radiation Level Distribution

Measurement and evaluation of exposure radiation levels with workers engaged in emergency work at the Fukushima Daiichi NPS has been implemented continuously since the Tohoku-Chihou-Taiheiyo-Oki Earthquake. The monthly external exposure for workers engaged in radiation work at the Fukushima Daiichi NPS from the accident in March 2011 until February 2012, as well as an accumulated radiation level (accumulation of external exposure and internal exposure radiation level totals) distribution is indicated in [Attachment 13-3].

The average worker external exposure value for 3,765 people during March 2011 was high at 13.81mSv; however, the average value for 5,128 people in April of 2012 was 1.07mSv/month due to decreasing trends in field work environment dose rates. This is approximately 10 times the normal annual average exposure radiation level of 1.4mSv/yr (FY2009) for workers at the Fukushima Daiichi NPS, and approximately 10 times higher than normal outage environments even for work environments during March 2012.

The employee and nonemployee exposure radiation level distribution for March 2011 is shown below. According to this, it is clear that the exposure by TEPCO employees is pushing up the average.



Six workers suffered an exposure that exceeds the emergency worker radiation level limit of 250mSv; however, all of these workers were TEPCO employees who were operators or electrical/instrument engineers that were in the MCR following the accident to monitor instruments. As soon as it was discovered that these workers suffered a dose that exceeded 250mSv they were immediately removed from the Fukushima Daiichi NPS and have undergone health examinations and have been examined periodically by physicians. No impact to their health has been seen.

Long-term health management shall be implemented in accordance with radiation levels for emergency workers in the future, including those workers that suffered a dose that exceeded 250mSv. A government policy has been stipulated1 in regard to the long-term health management emergency workers and the policy calls for the implementation of periodic tests and examinations in accordance with radiation months; however, in addition to this, all efforts will be made to manage the help of emergency workers, including increasing the range of workers to be screened for cancer.

(2) Worker Exposure that Exceeded Radiation Level Limits

In regard to exceeding radiation level limits, the occurrence of events ① and ② below have been confirmed. The report regarding determination of the causes and formulation of the recurrence prevention countermeasures has been submitted to NISA, and currently exposure radiation level management is being enhanced and recurrence prevention countermeasures are being thoroughly implemented upon the instruction of NISA and the Ministry of Health, Labor and Welfare.

Furthermore, no abnormalities have been found in the results of medical exams performed on the following employees to date.

① **Two female TEPCO employees exceed radiation level limit stipulated by law (5mSv/3 months) law (5mSv/3 months)1**

Two female TEPCO employees (in their 40s and 50s) were engaged in fire engine refueling, desk work in the seismic isolated building, and caring for people who felt ill in the seismic isolated building, etc. Although they took appropriate radiological protection measures, such as wearing full face masks with charcoal filters, in working in the field, it is estimated that their effective dose exceeded the legal radiation level limit as a result of that they inhaled radioactive materials that had leaked from the outside into the seismic isolated building where it was difficult to prevent the influx of reactive materials due to the reactor building explosions.

Furthermore, on and after May 23, because women were not allowed to work within the Fukushima Daiichi NPS, there is no possibility that the above two female employees suffered exposure within the Fukushima Daiichi NPS after this day.

② **Six male TEPCO employees exceeded the emergency radiation level limit stipulated by law (250mSv)**

The six male TEPCO employees are MCR operators and electrical/instrument related maintenance workers that engaged in operation and monitoring work and also work to restore monitoring instruments, etc. in the MCR, etc. for several days following the day of the earthquake.

As a result of (1) the influx of contaminated air into the MCR through the MCR's emergency door that was damaged by the reactor building hydrogen explosions (through which gasoline generator power cables were passed at the night of March 11 in order to supply power to the MCR), (2) the fact that it was difficult to accurately take protective action, such as appropriately selecting, wearing, and obtaining the mask, in conjunction with the quick escalation of the event and (3) other factors, these workers ingested radioactive materials.

When the emergency worker radiation level limit of 250mSv was adopted, the Radiation Council issued a statement regarding the determination that the limit is appropriate. The statement conveyed that the limit was determined to be appropriate in light of consistency with internationally allowed recommended values (500mSv), 500mSv is the threshold of tissue damage and the definitive effect of the value is internationally determined not to lead to acute disorders or cause delayed serious disorders. The radiation level limit of 250mSv is positioned in this way from the perspective of the effects of radiation and protection; however, whereas emergency workers were managed in accordance with the aforementioned radiation level limits, and as mentioned previously, some emergency workers during the initial stages of the accident ingested radioactive materials and as a result suffered a dose that exceeds radiation level limits, steps have been taken for stricter control to ensure that radiation level limits are not exceeded since the above event.

Under the management background as stated above, as of the present, no radiation damage had occurred among all emergency workers, including workers that suffered a dose that exceeded radiation limits. Whereas workers responded amidst extremely harsh conditions during the initial stages of the accident, it is considered that substantial safety management had been implemented from the perspective of preventing radiation damage.

[Tepco Report] Chapter 13 Section 3

The following isssues can be raised in association with radiation exposure of plant recovery workers.

Radiation exposure of plant recovery workers – network for urgently borrowing alarm pocket dosimeters (APDs)

- Although many APDs were provided as aid supplies from other NPSs, these APDs were simply stored and remained unused owing to a lack of communication. There were not enough APDs and by 15 March, not every worker was able to wear an APD, which led to the decision that only the leaders of each operational group would wear APDs on behalf of the entire group.

Radiation exposure of plant recovery workers – control of internal exposure in an emergency

- The individual doses of 6 workes exceeded 250mSv, which was the dose limit for emergency workers temporarily prescribed after the accident.
  - The main control room outside the controlled areas was not equipped with a sufficient number of full-face masks. In addition, since the number of charcoal filter masks was not sufficient for all of the workers, some staff members just wore dust filter masks until charcoal filter masks were delivered from the Seismic Isolation Building in the evening of 12 March.
  - There were actual cases in which staff members sometimes ate and drank in the main control room without wearing masks, sometimes took their masks off and spent short periods of time without them, and sometimes loosened their masks because their breath fogged up their masks or their masks were too tight, causing headaches. Moreover, there was a possibility that the arms of glasses created a gap between the face and the mask.
  - The emergency doors to and from the main control rooms of Units 1 and 2, which had been bent and twisted by the blast from the hydrogen explosion in Unit 1, were only temporarily sealed with vinyl sheets. Meters on the side of Unit 1 were located in a stream of air flowing from the emergency doors. In the main control room of Units 3 and 4, some staff members also spent most of their time checking the meters nearest the emergency doors, which were bent and twisted by the blast of the explosion.
  - Some staff members in the main control room of Units 3 and 4 did not take stable iodine tablets until they moved to the Seismic Isolation Building on the evening of 13 March.
  - Since the ambient dose in the whole body counter (WBC) room became higher following the accident, those WBCs could not be used. From 22 March, TEPCO borrowed vehicle-mounted WBCs, which were installed at the Onahama Call Center, and internal exposure tests of the workers were commenced.
  - When a high contamination was observed, personal decontamination was carried out to remove external contamination. Since the worker then needed to wait for approximately two weeks to receive a test purely for internal exposure, it took time to assess the high-level internal exposure.

- The doses of two female employees significantly exceeded the 5mSv three-month upper limit for female radiation workers, although they took appropriate radiological protection measures such as wearing full-face masks with charcoal filters whilst working in the field, since the double-entry doors to the Seismic Isolation Building were not airtight and the doors to the Seismic Isolation Building were bent and twisted by the hydrogen explosions in Units 1 and 3.

- 178 workers showed thyroid gland equivalent doses of over 100mSv, and 25 workers under the age of 40 did not take iodine tablets.

Radiation exposure of plant recovery workers – control of localized exposure in an emergency

- On 24 March, two of three workers who were installing electric cables under the surface of the basement floor of the Unit 3 turbine building were exposed to high radiation doses while working immersed in contaminated water, because they were wearing low quarter shoes. Although it was made clear, after getting cleaned up and having a checkup and getting tested to measure internal radiation doses, that neither worker suffered radiation heat burns on their feet, there had been a possibility of suffering from radiation heat burns due to continuous localized exposure.

Radiation exposure of plant recovery workers – managing access to and from a controlled area in an emergency

- After the nuclear accident, access to and from the controlled area of the management system was initially impossible for calculating the radiation dose of individual radiation workers. It was then decided to manually calculate the radiation dose of individual radiation workers using APDs. (On 14 April, five simplified instruments were installed in the Seismic Isolation Building for gaining access to and from the controlled area management system. At the same time, a radiation work permit with bar code patterns was introduced so that the names and radiation doses of individual workers could be automatically recorded).

- From the date of the nuclear accident to 10 May, radiation workers were allowed to carry out their duties after receiving a brief 30-minute explanation about how to protect themselves from radiation and how to wear protective equipment.

(5) Communication to the public

Descriptions about communication to the public are given in **[Governmental Interim Report]**, **[Governmental Final Report]** and **[Nongovenmental Report]** in

the following way.

8. Details of events in areas where there may be problems with the provision of information to the public

(1) Institutional arrangements for the dissemination of information concerning the Fukushima nuclear accident

The dissemination of information about the Fukushima Dai-ichi nuclear accident was started first independently by (1) the Chief Cabinet Secretary, (2) NISA, which is the administration agency for TEPCO, (3) the Local Nuclear Emergency Response Headquarters (only after it was transferred to the Fukushima Prefectural Office on March 15), (4) Fukushima Prefecture, and (5) TEPCO. However, from March 12 the dissemination was conducted after getting the approval of the Prime Minister's Office in advance as described below, and then since April 25 the press release has been carried out under one umbrella by integrating the publicity of the Government and TEPCO as described in III 4 (2) b above.

From March 12 to 15, the Local Nuclear Emergency Response Headquarters did not deal with the press because the Off-Site Center, in which the Headquarters was established, was located within the evacuation area (Okuma-town).

(Omission)

(6) Announcement concerning the detection of tellurium, etc.

a. Publication of the results of the radionuclide analysis by NISA

As described earlier in 1(1) b, Fukushima prefecture conducted radiation monitoring around the Fukushima NPS during the period from March 11 to 15. As a result, radioactive materials such as iodine 131 and 132, cesium 137 and tellurium 132 were detected in samples of: (1) atmospheric suspended dust collected in Namie-town during the period from 08:39 to 08:49 on March 12, and (2) atmospheric suspended dust collected in Minamisoma-city during the period from 13:20 to 13:25 the same day.

However, the secretariat of the Nuclear Emergency Response Headquarters did not publish immediately most of the results of the monitoring conducted during the period from March 11 to 15, and disclosed most of it for the first time on June 3.

b. Process until publication on June 3

When publishing the "Results of the Emergency Monitoring in the Vicinity of the Fukushima Dai-ichi and Dai-ni NPS (conducted from March 11 to 15)" on June 3, the Local Nuclear Emergency Response Headquarters explained the process until the publication as in the following: "the Local Nuclear Emergency Response Headquarters evacuated from the Off-site Center in Okuma-town on March 15. As it was necessary to check the data left at the Off-site Center, the staff of the Off-site Center visited the building of the Center in Okuma-town again to retrieve the related files and integrated the results of the monitoring on May 28. Now we can publish the results today on June 3."

However, the results of the monitoring conducted in the vicinity of the Fukushima NPS in the period from March 11 to 15 had been transmitted from the Local Headquarters to the secretariat of the Nuclear Emergency Response Headquarters. The staff of the secretariat of the Nuclear Emergency Response Headquarters who received the transmitted results published only the results of the monitoring that had been integrated in the form of tables by the Local Headquarters, and did not integrate by himself the other results into the form of tables or any other form and left them as was without publishing. Early in May, the secretariat of the Nuclear Emergency Response Headquarters started to integrate the monitoring data that had not been published and prepared them for publication as well as arranging the unpublished results of independent calculations using SPEEDI for publication. The secretariat instructed the Local Headquarters to arrange the unpublished monitoring data for publication. According to the instruction, the Local Headquarters integrated the monitoring data and retrieved the materials left in the Off-site Center in Okuma-town. At that time the aforementioned unpublished data were retrieved and integrated, and then published

on June 3.

(7) Ambiguous expression of no " immediate" effects on health

The Government often explained, "It does not have immediate effects on health" about the influence of radiation on the human body. For example, in the Chief Cabinet Secretary's press conference at approximately 18:00 on March 16, the Government explained that "It is not values that will have immediate effects on the human body" about the monitoring results on the same day (the values over 30μSv/h had been obtained in Iitate, Minamisoma and Namie); the Government also explained in the Chief Cabinet Secretary's press conference at approximately 16:00 on March 19 that "Please understand that the radiation dose does not have immediate effects on the health of citizens (even if you temporarily ingest food from which radioactive materials exceeding the provisional limit are detected), so please act calmly" concerning the detection of radioactive materials exceeding the provisional limit prescribed in the Food Sanitation Act from the milk extracted within Fukushima Prefecture and the spinach harvested within Ibaraki Prefecture. In addition, the Consumer Affairs Agency explained on the Agency's web on March 20 that "It is not believed to have an immediate effect on your health even if you occasionally ingest food in which radioactive materials exceeding the provisional limit prescribed in the Food Sanitation Act were detected" in the message "About Delivery Restriction on Food Because of Detection of Radioactivity" from the Minister of Consumer Affairs, Mr. Renho. Similar explanations were repeated in the later messages of March 21 and 23. Furthermore, NSC also explained to the public that "Even if you continue to ingest food in which radioactive materials exceeding the prescribed limit are detected, it will not have immediate effects on your health" in the notice "To the People Living Outside the Areas where Evacuation or Sheltering Indoors is Conducted" on March 21, 2011.

It seems that the expression "immediate" effects was used on the basis of the following scientific knowledge: the causalities between radiation exposure and the occurrence of diseases such as cancer is not clear for low-level radiation exposure; and it will take a considerably long time for cancer to occur if it ever does. In fact, the expression "It does not have immediate effects on the human health" may be interpreted by some people as "it is unnecessary to be anxious about the impact on the human health," while it may be interpreted by other people as "It does not immediately affect human health, however, some effects will be brought about on the human health in the longer term." However, it was not necessarily clear which one the intended meaning was of the expression and there was no detailed explanation about it.

The Consumer Affairs Agency deleted the word "immediately" from the aforementioned message on April 1. With regards to the intention to have used the expression "It cannot be considered to immediately affect..." in the "Q&A for Food and Radioactivity" page on the Agency's website, the Agency explained that acute symptoms would not develop in the human body even if food in which radioactive materials exceeding the provisional limit were detected were occasionally ingested because the radiation dose from the ingested food is very small, but that the influence in case when the ingested radioactive materials accumulate in the human body cannot be completely denied because they are radioactive.

[Governmental Interim Report] Chapter V 8

(5) Problems of provision of information to the nation and the international society

As mentioned in Chapter V 8 above, viewed from the perspective of residents near the disaster site who were forced to evacuate, and from the perspective of the Japanese people as a whole, in many ways the manner in which the Government provided information to the Japanese people after the accident created the impression, indeed the suspicion, that it was not telling the facts rapidly and accurately. When explaining the reactor core situation (especially the core meltdown issue) and the crisis situation at Unit 3, and when conveying information on the effect of radiation on the human body, the Government frequently repeated difficult-to-understand explanations such as, "The situation is not something that would have an immediate effect on the human body."

In the event of a nuclear emergency, which can gravely affect large areas and where the situation

can change from moment to moment, the way the competent authorities provide information within the country and abroad is an extremely important issue. 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. This Investigation Committee intends to continue investigating and inquiring into this issue further, and shall present necessary proposals regarding it in its final report.

There is something to be noted, too, with regard to providing information to other countries. Immediately after the decision was made to discharge contaminated water into the sea, the decision was executed without prior explanation to neighboring countries. This event included elements that led other countries to distrust Japan's nuclear emergency response, even if the action did not flout treaty obligations (for example, the Convention on Early Notification of a Nuclear Accident). This should serve as an important lesson for the future.

[Governmental Interim Report] Chapter VII 5

f. Analysis concerning the provision of information to the public

(Omission)

(c) Publicity about the impact of radiation

When conducting publicity activities concerning radiation exposure or concerns for radiation exposure to residents during the accident at the Fukushima Dai-ichi NPS, the government often used the expression "immediate (no immediate effect on the human body")". Chief Cabinet Secretary Edano, taking a responsible role of government announcements, used often this kind of wording. He mentioned at the beginning as, regarding low level radiation dose exposure of residents, for example, "it does not harm human health much" (at around 08:30 on March 13), "the situation will not develop to harm health in our view" (at around 15:30 on the same day), or " a quantity not to worry about" (at around 21:00 on March 14). At the subsequent press conferences he began to use the expression as "immediate (no immediate effect on the human body);" for example: "in broad strokes, no immediate effect on human body," at around 18:00 on March 16, regarding monitoring figures of the same day at around 20 km from the Fukushima Dai-ichi NPS; or "Your thorough understanding and response with coolness are cordially requested, since the figures are not at a level that immediately affects your health (even if you take tentatively the food which contained radioactive materials exceeding the provisional regulation values)" at the press conference at around 16:00 on March 19, regarding radioactive materials detected from milk etc. exceeding provisionally regulated values. Later in the hearing by the Investigation Committee, Chief Cabinet Secretary Edano explained as "(We) Used (the expression) for implying that the effect of accumulated low level radiation exposure was not obvious, but at least the value was in a level not to cause acute symptoms," referring to the expression "immediate…"

Besides, the expression "immediate (no immediate effect on health)" was also used on the Consumer Affairs Agency's home page and in the NSC bulletin as mentioned previously in Chapter IV. 8. (8).

In the background of such expression of "immediate," there is scientific knowledge regarding low level radiation exposure that correlation between radiation exposure and development of cancer etc. is not obvious, and it will take considerably long time to become cancerous even if correlation exists. Chief Cabinet Secretary Edano's explanations mentioned above are likely to be based on this scientific knowledge. However, this expression "no immediate effect on the human body" could refer to "there is no need to worry about the effect on the human body" or conversely, "while there is no immediate effect on the human body, there are long-term effects to the human body." It was not necessarily clear which meaning the expression had been used in reference to. Expressions such as this, which could be comprehended in more than one way, should be avoided in the use of publicity in times of emergency, and is an important issue to be reviewed in the future from the perspective of risk communication.

[Governmental Final Report] Chapter VI 1

(7) Issues of the provision of information and risk communication

When a nuclear disaster that has a serious impact on a wide area occurs and additionally where the circumstances change from one moment to the next, the approach taken to disclosing information domestically and internationally by the institutions concerned is extremely important. There are many means of conveying information, including press conferences and websites, but unilaterally conveying a decision by the government or an expert is known as a risk message. However, when conveying information in the case of a nuclear disaster, unilateral risk messages will conversely pose a danger of fueling confusion and mistrust among the people, because it will involve communicating information on sophisticated scientific and technical matters and information on radiation and radioactivity that bears little connection to the everyday lives of the general public. It is desirable to communicate disaster-related information while getting feedback on things such as what kinds of information citizens need, particularly citizens in the vicinity of the accident site, and how these citizens are perceiving (interpreting) the information that has been communicated.

As already stated, the ways in which information was provided from the government to the public in the aftermath of this accident raised many questions and doubts as to whether the information had been communicated in a prompt and accurate manner, from the perspective of the residents in the surrounding areas who had had to evacuate, and the people at large. Examples are: the way of providing information on the situation and predictions of dispersion of radioactive substances, which is important in the evacuation of residents in the vicinity; way of providing information on the core conditions (in particular, core meltdown) and the critical conditions at Unit 3 of the Fukushima Dai-ichi NPS; and repeated explanations of "there is no immediate effect on the human body," that were difficult to understand, when providing information on the impact of radiation on the human body.

In this way, irrespective of the circumstances, as a result of cumulative problems such as delays in the transmission and release of urgent information, the holding back of press releases and the lack of easy-to-understand explanations, citizens in the vicinity were prevented from making appropriate autonomous decisions. Additionally, these problems fueled doubts and mistrusts among citizens, including that "the government and TEPCO are probably covering something up." As a risk communication approach at a time of an emergency disaster, it was inappropriate.

A fundamental principle of public relations is to convey facts promptly, accurately and in an easy-to-understand manner. Even in an emergency disaster, adhering to this principle is crucial because it serves eventually to help people in the vicinity to make appropriate autonomous decisions and prevents unnecessary uncertainty and confusion taking hold among citizens. At the same time "promptness" and "accuracy" are sometimes in conflict with one another. In that situation it should be kept in mind that if sacrificing "promptness" in order to ensure "accuracy," there is conversely a danger of inviting citizen's mistrusts and concerns. When a situation develops in which information cannot be obtained and accurate public relations are not possible, it is both necessary and important to communicate that situation as it stands.

Additionally, looked at from the standpoint of being "easy to understand," the communication on evaluative facts requires particular consideration. As facts to be included in publicity, in addition to already-released and already-known simple facts (for example, an explosion occurred at the reactor building or contaminated water flowed into the sea, etc.), there are also evaluative facts that can be inferred from various already-known facts (for example, a core meltdown, or the impact of radiation on the human body, etc.). Unless these types of evaluative facts are explained with a great deal of care, more than occasionally it will be difficult to gain citizens' understanding. Where evaluative facts are concerned, it may be believed that in some cases it is probably not possible to say anything conclusive due to insufficient information or the uncertainty of the situation, but even in those circumstances it would be desirable to provide an explanation to that effect and then disclose information as promptly as possible.

The following can be said for all emergency situations, not just for nuclear disasters, but it is necessary to build mutual trust between the public and the government and to provide relevant information in an emergency while avoiding societal confusion and mistrust. To this end, a risk

communication approach on risks and opinion exchanges thereupon should be adopted for a consensus building among all stakeholders based on mutual trust. This time, amid the state of confusion arising from the outbreak of a complex disaster, as previously noted a large number of problem areas could be detected in the government's public relations activities, including those of NISA, from a risk communication perspective. The government should examine, by institutionalizing an appropriate body, how to provide relevant information in an emergency to the public, promptly, accurately, and in an easily understandable as well as clear-cut (not misleading) manner. Inappropriate provision of information can lead to unnecessary fear among the nation. Therefore, an expert on crisis communication may be assigned for providing appropriate suggestions to the cabinet secretary responsible for information provision to the public in an emergency.

[Governmental Final Report] Chapter VI 2

Chapter 4 Risk communication

[Outline] In this chapter, the appropriate method of risk communication in the Fukushima Daiichi nuclear disaster implemented by the Kan Administration, and the effects on public concern and efforts to bring the accident under control are discussed. From a public opinion poll, it has become clear that the public had a strong anxiety regarding information provision on the nuclear emergency by the government. Communication with the public on the status of nuclear reactors and the risks of low-dose radiation effects was a field in which the government had no experience. There were various trials and errors in finding an appropriate way for rapid and accurate disclosure of information. In addition, the Prime Minister's office had originally shown weakness in foreign public relations. A system of risk communication was gradually completed after the accident.

Moreover, an appropriate way of risk communication in the era of social media is also discussed. Social media, e.g., Twitter, Facebook and blogs, was utilized as a communication tool following the Fukushima Daiichi nuclear accident. Here, information on the internet provided by member of the public and experts, and official announcement from the government and TEPCO is compared, and it is examined whether or not the government provided information required by people.

Section 1 Public anxiety regarding effects of nuclear emergency

There is a significant gap in risk perception between the general public and experts, regarding nuclear technology and health risks owing to radioactivity. Owing to large differences in knowledge and information amount, there is originally a problem that it is difficult for the general public and experts to communicate with each other. It becomes particularly important to provide accurate information in an easy-to-understand manner to the public in the case of a nuclear disaster. The Japanese people would be highly sensitive to issues regarding radiation owing to their experience of radiation in Hiroshima and Nagasaki.

However, after the Fukushima Daiichi nuclear accident, serious anxiety regarding the health effects of radioactive materials spread among Japanese citizens. According to a public opinion poll implemented by newspapers with national circulations on April 2010, approximately 70% of the respondents responded that the information provision and explanation by the government was inappropriate. This quantitively endorses the fact that strong anxiety regarding the unknown disaster and frustration against the explanation by the government was broadly shared. In addition, according to the public opinion poll implemented by NHK, 60 to 70% of the respondents reported a low estimation of the government's response to the Fukushima Daiichi nuclear accident, which had been continuously serious since the government announced. After TEPCO's announcement of the occurrence of a meltdown at the early stage after the earthquake and the increase in criticism of the government's initial responses, this estimation became lower. Moreover, as mentined in Section 4, such an elevated anxiety regarding radioactivity contamination can be seen from the trend in the social networks. After the accident, searches for terms related to the nuclear disaster such as "cesium" and "reactor meltdown" on the internet rapidly increased. Websites and Twitter accounts of experts who did not have a governmental role attracted much attention from citizens seeking a second opinion against the governmental information. Special Advisor to the Cabinet, Hiroshi Tasaka, who made an endeavor to respond to the nuclear power plants just after the accident and

continued to suggest the importance of social and mental risk in the information provision of the nuclear disaster, pointed out that loss of trust from citizens occurred in reality looking back a series of responses to the accident. Also, he sugggeted that we should learn from the failures of governmental risk communication, "At first, the government has to deeply recognize that it has lost the confidence of its citizens regarding nuclear administration."

[Nongovernmental Report] Part 2 Chapter 4 Section 1

(a) Understanding of low dose radiation exposure

Descriptions about understanding of low dose radiation exposure are given in **[Governmental Final Report], [National Diet Report]** and **[Nongovenmental Report]** in the following way.

(g) Public understanding of radiation effects

Radiation effect to human body was reviewed in the Interim Report Chapter V. 4. (1), but cannot be regarded easy to understand since it requires knowledge to understand the concept of such as stochastic effect. Furthermore, it is also hard to accept that the general public had sufficient opportunities to learn about scientific characteristics of radiation or its effect to human body at schools or in a community19. It is reported that a considerable number of the public get fears against radiation effect regarding the accident at the Fukushima Dai-ichi NPS, and there are victims of fraudulent businesses taking advantage of such people's fears. The facts stated above are likely the cause of these happenings.

This accident has served as a reminder of the need not only to take all possible precautions in order to protect ourselves against radiation, but also to "fear radiation properly." Knowledge such as the following will be useful in order to "fear radiation properly":

(i) Radioactive materials are not contagious like a virus;
(ii) The average annual radiation exposure from natural radiation (including internal radiation exposure from foods etc.) without accidents at nuclear power stations etc. is about 2.1 mSv a year in the county (international average is about 2.4 mSv a year);
(iii) Iodine-131 absorbed in human body accumulates in thyroid gland, but since its half-life is short, only about eight days, the residual iodine-131 originating from the accident at the Fukushima Dai-ichi NPS remains only little;
(iv) The physical half-life of cesium-134 is two years and that of cesium-137 is 30 years. A large amount of them still remain in the environment, but unlike the iodine, they do not accumulate in particular parts of human body upon absorption. They are distributed uniformly to muscular tissues of the whole human body, and half of them will be removed from the adult's body in 90 days;
(v) Human bodies originally contain about 120 Bq/kg of radiation materials including potassium-40 and carbon-14;
(vi) There are foods in our daily life consumption that contain 100 Bq/kg or more of radioactive potassium; and
(vii) Correlation between exposure dose and cancer initiation is not apparent in an environment of less than 100 mSv, but the radiation protection principle assumes a direct proportion between them.

There is, of course, a need to put utmost effort into preventing unnecessary exposure in the future, and at the same time, as many opportunities as possible should be institutionalized for the public to get knowledge and deepen their understanding of radiation. By doing so, the individuals would be able to judge the radiation risks based on correct information; in other words, they would be freed from unnecessary fears about or from underestimating, the radiation risks because of the lack of information.

[Governmental Final Report] Chapter VI 2

b. Communicating risk from radiation during the accident

How was the risk concerning radiation communicated during the accident?

Radiation cannot be felt. If the dose is low, its effects do not immediately appear. However, the possibility that it can cause leukemia or cancer years, or even decades, later, is generally agreed upon.

The residents who had to live in an environment contaminated by radioactive material after the accident sought information about the level of radioactivity that would serve as a basis for making decisions. Mothers, in particular, sought accurate information about the extent of the contamination in the food and drink they were giving their children, and about the radiation dose from the environment and its effect on their health. The information that was made available to the residents was not satisfactory. MEXT not only failed to communicate the results of their environmental monitoring, for example, but later admitted that it had no intention of letting the residents know the results directly after the accident. Public dissatisfaction became obvious when many of the mothers in Fukushima Prefecture and society at large levied criticism at the announcement of twenty mSv per year as the standard for reopening schools.

The government has yet to respond to the residents' urgent question: "What is the level of the environmental radiation where we live and how will it affect our health?" The content of the information the various government agencies is supplying to the residents more one year after the accident has not changed from prior to the accident, and their attitude towards children and students remains the same.

Many of the residents do not know that the risks to their health increase with an increase in the radiation dose, and that there is no safe level. If they understood what the risks meant in terms of the effect on their lives and how those risks could be measured and mitigated, then that would help them to decide how to go on with their daily lives.

The understanding of the effect of radiation is different for each of the residents, so it is necessary to understand the differences between those exposed. For example, explanations for infants, the young, pregnant women or people with especially high radiation sensitivity should be different from explanations to other groups. Only after residents have a deep understanding of what is appropriate for them can they decide and act. When accidents occur and all they hear is a message of safety and reassurance, such as that following the Fukushima accident, residents will react with either trust or disbelief as the information presented is insufficient for them to make a proper analysis.

[National Diet Report] Chapter 4, 4.4.1

3. Explanations to the public concerning low-dose radiation exposure

There is no doubt that anxiety regarding low-dose exposure risk among people spread after the accident, taking into consideration people's highly elevated frustration with governmental information provision as mentioned in Section 1. The reason for the increase in the nation's anxiety is based on multiple backgrounds as discussed in Chapter 2, Sections 2 and 4, but the issues raised from the viewpoint of governmental communication are many. Statements of Chief Cabinet Secretary Mr. Edano who became practically the highest ranking person for the purpose of explaining the nuclear disaster to people in place of the Prime Minister are reviewed below.

The government—and in particular Chief Cabinet Secretary Edano—repeatedly stated that the radioactive elements released into the environment after the accident had "no immediate effect on human health." The ambiguity of this statement fostered continuing public debate concerning the possibility of adverse effects on health due to long-term exposure to radiation.

Edano provided the following explanation at the Budget Committee meeting of the House of Representatives in November 2011:

"During the first two weeks following March 11, I held 39 press conferences. At seven, I stated that 'there is no immediate effect of radiation on the human body or human health.' At five of these seven, my statement was made in the context of questions concerning food and drink. I never made any general statement that there would be no adverse effect to health. Rather, I repeatedly

stated that there is a specified standard value for the level of radioactivity detection in milk which would adversely affect the health if its ingestion were to continue for one year, and that even if such milk were ingested once or twice, there would be no immediate problem." Regarding this point, the expression "immediate" is used in 10 of Chief Cabinet Secretary Edano's statements on radiation effects on health in the first two weeks.

Chief Cabinet Secretary Edano also stated at the Diet that the health assurances provided under these statements were limited to one or two ingestions. A review of actual records of his statements, however, casts some doubt on whether this description was entirely reasonable. The record shows, for example, that at his March 20 press conference, he said: "… even if a person continues to ingest spinach containing radioactive materials at the recently detected concentration level, it is inconceivable that it would immediately affect health." Likewise, at a press conference the day before, when responding to a question on the risks related to milk, he said: "If, hypothetically, a person were to continue to ingest milk containing radioactive materials at the recently detected concentration level for one year at the average rate of ingestion in Japan, the radioactive dose exposure would be about the same as one CT scan." The phrase "about the same as one CT scan" may naturally be taken to imply that the dose was not large; it is difficult to hold that this statement did not represent a public assurance of safety.

Days later, he told reporters that "even if something having this value or higher were ingested several times or for several days, it could not possibly have any immediate effect nor would it have any future effect"; the implication is quite clear that it is based on the assumption of a certain numerical limit. However, this statement is made in conjunction with an explanation that a provisional standard value—that is, the level of radioactive material the government declares acceptable to ingest —pertains to the absence of adverse effects after ingestion for one year. Such a statement and other explanations easily led to public misunderstanding. If we assume that his response given at the Diet was true to his intent, then it can only be concluded that statements were made which, in their overall effect, were misleading.

Moreover, Chief Cabinet Secretary Edano compared with exposures received during international air travel and CT scans and annual natural background exposure. Isuues such as the possibility of confusion due to the variations of such comparisons and whether or not voluntarily received exposure could be a standard for comparison with passively received exposure should be verified.

First of all, regarding the health risks of radioactivity, it was difficult for the general public to fully understand the relationship among many technical terms and the degree of health effects, because technical terms that are difficult to understand such as "Sv", "Bq", "radioactive iodine" and "radioactive cesium" were used in TV news, etc. In addition, many staff members who attended the briefing by Edano told us that there was no time to prepare appropriate expected questions and answers. There were cases in which Edano had to explain the situation of the accident at the interview meeting just after a secretary or NISA's staff simply explained an overview of the latest situation regarding nuclear power stations and radiation monitoring.

With the benefit of hindsight, Edano has reflected on those press conferences, saying, "If I spoke in terms of the reports themselves as they were brought to me, it is quite certain that very few would be able to understand the content. … For me, the most mentally wrenching problem was the degree to which I could speak on the matter at hand in a way that would be at least barely intelligible." In this way, under severe time constraints in a situation of urgency, the process of translating the difficult specialized terminology to readily understandable Japanese unavoidably proceeded in hurried consultations with the agency's Deputy Director-General Yasui, Sakai of the National Institute of Radiological Sciences, and a few other advisors, or on a largely ad lib basis by Edano. In this light, we recommend that the government—in conjunction with the media and guided by the lessons that have emerged concerning the inherent difficulty of communicating low-dose radiation risk to health—develop methods to communicate such information to the public and formulate and adopt a unified risk scale, which would provide a more objective and comprehensible measure of the level of low-dose radiation risk to health.

[Nongovernmental Report] Part 2 Chapter 4 Section 2

(b) Mental health care

Descriptions about mental health care are given in **[National Diet Report]** and **[Nongovenmental Report]** in the following way.

4.4.6 Mental health impact of long-term evacuation

1. Importance of mental health support measures

Those involved in the Chernobyl nuclear accident have pointed to the importance of mental health support measures for residents living in the vicinity of a nuclear disaster. In the report issued to mark the 25th anniversary of the Chernobyl nuclear accident in Ukraine, it was noted that various psychological states had been observed in residents following the accident in 1986. These include the "syndrome of victimhood," in which a large number of the affected individuals refer to themselves as a community of victims over their entire lives, and the "syndrome of social exclusion," where an absence of initiative and a dependence on the government for support dominate the collective consciousness of affected individuals.

In addition, at the seventh meeting of this Commission, a representative of the Ministry of Emergency Situations of Ukraine noted that "with regard to the issue of how stress affects human health . . . we came to understand that stress has an adverse impact on health and can cause physical ailments and illness." In this way the impact on the mental health of residents and workers at the nuclear power plant affected by the accident was pointed out.

The importance of mental health support measures in a nuclear disaster was noted in a domestic context too, following the JCO Criticality Accident. NSC pointed to the importance of introducing mental health support measures and bringing in experts directly following the occurrence of a disaster, including the appointment of a mental health expert at the emergency nuclear response headquarters established by a local government directly after a nuclear disaster, and the necessity of ensuring that mental health support bases are established in prefectural and municipal healthcare centers.

2. Impact of the accident on the mental health of the residents and support measures

Following the accident, there were many residents who endured mental stress as a result of living as evacuees in evacuation centers. In the free comment space provided in the survey distributed to evacuated residents by this Commission, there were many accounts of mental pressure following the shock of the accident, with some people revealing they were taking tranquilizers. From the doctors who visited the evacuation centers, we were also told of the need for mental health care for many of the patients who they had examined.

Since around the end of March 2011, MHLW has been engaged in efforts to dispatch "mental healthcare teams," composed of psychiatrists and mental health nurses from around the country, to the affected areas. These "mental healthcare teams" have been dispatched to evacuation centers and other locations to attend to the mental health needs of residents affected by the earthquake and tsunami, as well as residents who evacuated due to the nuclear accident.

In cooperation with Fukushima Prefecture, MHLW established a mental healthcare center in February 2012 to provide consultation support for psychiatric disorders such as post-traumatic stress disorder (PTSD), and to implement home-visit consultations for people living in temporary accommodation.

As mental healthcare is not an issue that can be resolved in the short-term, it will be necessary to maintain a continuous response in the future.

[National Diet Report] Chapter 4, 4.4.6

(c) Communication through mass media and internet

Descriptions about communication through mass media and internet are given in **[Nongovenmental Report]** in the following way.

Information transmission by government

The Cabinet's Twitter account, @Kantei Saigai, went live on March 13 and gave relevant information from ministries and agencies with tweets on press conferences.

Operated around the clock by three young members of the Cabinet Public Relations Office working in rotation, the Tweets were typed, confirmed by a Public Relations Officer, and then posted; in some cases, the Public Relations Officer wrote the posts himself. By the end of the month, the account had 300,000 followers. Regular information provision from @Kantei_Saigai was started from March 14 (midnight on March 13) For example, on March 13, the Cabinet published 48 Tweets, mostly consisting of plain text transcripts of Prime Minister Kan's press statement, but nothing on radiation doses, aside from a link to Deputy Chief Cabinet Secretary Fukuyama's definition of "microsievert" and a message noting that no abnormalities were found in monitoring results near the main gate of the nuclear power plant. Two days later, the Cabinet posted 62 tweets, largely quoting from press conferences and announcements by Prime Minister Kan and Chief Cabinet Secretary Edano. Despite heightened concern regarding radioactivity in mid-March, the Cabinet's number of Tweets was only 23 on March 23, and 19 the following day. Such Tweets were related to the detection of radioactive iodine in the water at the Kanamachi Purification Plant. While the Cabinet instructed parents to avoid giving tap water to infants in and around Tokyo, it also tweeted comments like, "It is safe to drink tap water " (March 23) , and "For anyone other than infants, there would be no physiological effect (from drinking such tap water)" (March 24) . Despite the confusing messages, the government still did not interact with its Twitter followers. In some cases, the off-target Tweets were quite extreme: One hospital's deputy director Tweeted that patients were on the verge of starvation. Member of the Self Defense Forces were flagged not to disclose information in the process of the response. There are phenomena in support of Edano such as "#Sleep Edano" and "#Bear-up Edano" as a response to governmental information provision. This spread after an internet user attached the hashtag "#edano_nero" on Twitter. However, Edano had no knowledge of what happened on the internet, he did not read newspapers for two weeks after the disaster and just heard it from the secretary in charge of public relations.

The fact that the Prime Minister's office utilized Twitter motivated other ministries and local governments to also use Twitter. The issue here is "masquerade", a situation in which someone or some organization different from the Twitter's owner uses the account. If the ministry's account was hacked, the reliability of information would be lost. Therefore, METI and MIC built a system to smoothly obtain an "authenticated account" for the purpose of confirming whether or not a user is authentic on April 5, in collaboration with Twitter. The guideline was also announced. This system was unified and published on the "Public Institution Social Media Portal" website.

By building this system, the public institutions became to be able to apply for an authenticated account and authentication of the twitter provided by official website for twitter, "Twinavi", if they applied from account registration page for public institution in Twinavi. Moreover, "J-government on Twinavi" in which accounts in the public institutions was consolidated, was simultaneously published at "Public Institution Social Media Potal" which was released from the METI. This led to ease in locating the official Twitters accounts of public instituions.

On March 30, METI and the Local Authorities Systems Development Center (LASDECL) jointly called on public agencies to make public information related to earthquakes and electric power available in HTML, CSV, or other small-volume data format. This request was made for several reasons. One was that files in large-volume PDF and Excel data formats tended to impede access at times of heavy usage. Another was the difficulty of information sharing with such files because of the limited viewing capabilities of cellphones. These formats were also difficult to use in terms of search facilitation and adoption of automated map display systems.

One of METI's objectives was to determine electric power usage and implementat power saving measures, mainly in the regions served by TEPCO. After receiving the data, MEXT called on the online community to utilize the data, through the Twitter account, @openmeti, which was the handle of its IT Project Office. Through these movements, the Yahoo Japan portal site and other sites processed the TEPCO data and displayed the state of electric power usage on their top pages or other prominent locations in real time.

Information transmission by TEPCO

TEPCO issued close to 10 daily press releases immediately following the onset of the Fukushima accident: The releases were only in PDF format. During the planned power outages on March 14 in particular, the PDF format made it especially difficult for users to search for the affected areas; this was only exacerbated by the fact that the company did not offer a complete list of the areas.

TEPCO launched its Twitter page (@OfficialTEPCO) on March 17. The first information was related to the planned power outages.

Users also criticized the company for not apologizing for the disaster itself. Within 24 hours, the company had 160,000 followers, which grew to 280,000 by the end of the month. TEPCO continued to tweet about planned power outages but, using the same approach as the Cabinet, did not interact with its followers.

Credibility of media after the disaster

According to an internet investigation entitled "Investigation on contact with media regarding the nuclear disaster following the Great East Japan Earthquake" carried out by Nomura Research Institute from 19 to 20 March just after the nuclear disaster, the answer of "credibility has become lower" after hearing information on the nuclear disaster was 28.9% for that announced from government and local govenments, which is significant compared with that of 9.0% for social media in which there might be a false rumor. Even in the case of the answer "credibility has become higher", estimation of the information from government and local governments was 7.8%, which is lower than 13.4% for the information from social media. On the other hand, in the case of the answer of "important media and information sources in relation to the nuclear disaster", information of the government and local governments in the internet occupied 23.1%, which is higher than 18.6%, that of newspaper companies (the first rank is TV (NHK), 80.5%; 36.3% for information of published newspapers; 43.2% for information of potal site).

It should be noted that the target of the internet investigation was people aged 20 to 59 living in the Kanto area, there was no estimation by users in the affected area (mainly Tohoku area) and the timing of the investigation was early. However, this investigation could be a reference for estimation of internet information at the early stage of the accident. The Twitter followers of @Kantei_Saigai numbered about 260,000 on 21 March, which was picked up by various news outlets. Most internet users would have known it. From this investigation, it was clarified that the reliability of the government drastically decreased although the information from the government and local governments regarding the nuclear disaster was provided via the internet.

It could be seen that in the responses to the nuclear accident, the government promptly started sharing information via the homepage and @Kantei_Saigai. The Twitter account was followed by more than 300,000 users in two weeks and played a role as an information provision tool for a large number of people. However, this did not lead to the improvement of the reliability of the government.

Comparing the interests of internet users with information provision from the government, on 15 and 23 March when there were a lot of internet searches and uploads on the topics of radiation or radioactivity, there were few topics regarding radiation provided by the government. The topics were just limited to an announcement of safe for the meantime and requests for a cool response to the event.

It can be seen from the high interest in radiation and radioactivity and the transient situation that citizen's activities to measure radiation were broadend to nationwide by using internet that many people considered this event as their own and their region's problem but not Fukushima's issue. While no information on high radiation hot spots was provided by the government and media, interested people started to measure radiation by themselves, disclosed measurement results on the internet and made their own network.

This is because information in connection with the public interests were not available because the government did not have bidirectional information exchange using characteristics of the social media.

From this background, there is a vulnerable system for information provision in the government.

At first, staff did not have a good understanding of social media. Although there was recruitment of staff understanding portal site and volunteer work by advertising companies, the advertisement and the portal site have characteristics of one-way information provision as seen in mass media, which is different from the bidirectional and real-time characteristics of the portal site. It was in September when bloggers were invited to the "Cabinet Public Relations Office, advisor of IT public relations". Comments and responses on Twitter have been raised as a topic in the Cabinet Public Relations Office, but did not reach the leader in the center of the responses to the accident.

On the other hand, Professor Hayano, who provided real-time information since the early stage after the accident, had few followers before the accident. At the early stage after the accident, he did not have many sources of information and wrote Tweets on the basis of information from TV. He collected much data by exchanging information through social media. Also, he connected with many expert researchers and became a hub of information exchange. He promptly responded to mistakes suggested by his followers and finally gained trust. By assigning him in the interactive exchanges, he could appropriately obtain information that people wanted and provide the relevant data. This indicates that it is important for social media to exchange information rather than only provide it.

In an emergency situation such as a nuclear accident, a large amount of information is exchanged, but in many cases, its reliability is uncertain. In particular, it is essential to gather experts who can explain what were said about highly expert knowledge such as nuclear power plants and radiation in an easy-to-understand manner. Professor Hayano understood people interests through social media and provided easy-to-understand information in real time as an expert.

Moreover, it is requied to provide accurate information in a timely manner like that commotion was stopped by calling an attension by an expert of the National Institute of Radiological Sciences (NIRS) to prevent a rumor's broadening. To let them have an interest on the information, it is also necessary to timely provide accuarate information. Mass media type communication such as one-way information provision from the government, cannot gain trust, but is simply a source of information.

In contrast with the insufficient information provision from the government, people who can provide information by themselves highlighted local radiation monitoring data, measured radiation by using their own surveymeters and expanded their information by developing a network using measurement results. Mr. Ishikawa, who works for the Natural Laboratory, received e-mail such as "It is great to be able to confirm the numerical value, whereas governmental information is uncertain. Only these data is available because governmental information cannot be relied on. I'm really appreciative." "Citizens are not idiots. We are cool, so there would be no panic after such data are disclosed. We become so anxious when the data are not disclosed."

Thus, a voluntary network for measuring data grew for people who have distrust of governmental information provision. On the other hand, elementary confusion occurred, such as mistakes in the measurement method of the survey meter. There were some people who continued to disclose their measurement data without understanding how to properly use the survey meter, which led to a situation where uncertain information continued to be spread.

The government, however, deserves credit for an initiative led by the Ministry of Economy, Trade and Industry (METI) that asked public agencies to provide their data. Thus, simple values were transformed to graphs that could be observed on portal sites, thus facilitating their ready understanding.

As social media flourished, mass media waned. As such, the public offered harsh criticisms online—a survey by the Nomura Research Institute found that, after the earthquake, the public did not trust mass media outlet any more, other than NHK. NHK actively used Twitter and blogs. Its Science and Culture Department blog @nhk_kabun had just 3,000 followers before the earthquake, but by March 21 the community had grown to 223,903. On many days, the number of Tweets exceeded 100, and the staff members later related that they had strongly felt the concerns and feelings of those people and relayed them as feedback to the broadcast commentators. This clearly demonstrated the need for mass media to receive as well as transmit information, in two-way communication.

One problem that clearly existed for social media is its inability to reach all generations and

levels in society. We fear that the "digital divide," and the resulting disparity in information access between those who use social media and those who do not, may further widen.

<Summary>

As a result of the above discussion, it can be said that the government could not implement the information provision that people required. There is no evidence that the government had an interest in people on the internet, at least during March after the nuclear disaster.

One cause of the problems information provision is the lack of understanding of the characteristics of communication via social media. The government had used social media from the beginning of the post-accident period, but did not respond in a bidirectional manner after receiving the information and only informed it in a one-way manner similar to conventional mass media.

It has been clarified that it is important to receive and analyze information via social media to implement a two-way communication rather than information provision.

Receiving information is possible by reading message in Twitter without depending on an expensive system and by utilizing a web service used in this verification, but the government did not implement it, too. It can be said that understanding of not only characteristics but also technology of the communication was insufficient.

Social media will become a more important communication tool in the future because the number of users continues increasing. However, whereas social media is a convenient tool, it has a dangerous aspect. To utilize it efficiently, we have to have sufficient knowledge regarding its characteristics, and the technology and dangers of social media.

On the basis of such reviews, it would be valuable for government to make a system for investigation and analysis of writing in the social media in relation to receipt of necessary information. A system that enables real time display of what internet users are interested in and awareness of the users' response to a keyword is now technically possible to make. If it is made, the system would have a role for information provision and responses. However, if the system fails to function in an emergency due to an error of computer or mechanical system, information provision would be impossible. It should also be noted that investigation of the writings on Twitter showed a very slight difference from monitoring.

Also, the role of the government in information provision should be fully discussed. To expand collaboration formed after this accident, such as collaborating with technical staff that can construct figures and tables in an easy-to-understand manner on the basis of existing data and explanation of relevant experts, in preparation with emergency situation, it is necessary to make a system that enables us to obtain available data in times of emergency, share it, and minimized unreliable data arising from problems associated with an emergency.

[Nongovernmental Report] Part 2 Chapter 4 Section 4

(d) Information delivery to oversea countries

Descriptions about information delivery to oversea countries are given in **[Governmental Interim Report]** and **[Govenmental Final Report]** in the following way.

(c) Prior notification of water discharge into the ocean

After the paperwork was completed, TEPCO and the Local Nuclear Emergency Response Headquarters notified the parties concerned such as the municipalities and the fishery cooperatives associations of the water discharge into the ocean. On the other hand, since TEPCO, NISA and others started the paperwork for the discharge on the morning of April 4 until they obtained the consent of Prime Minister Kan at 15:00, they did not notify the authorities concerned (such as the Ministry of Foreign Affairs, the Ministry of Agriculture, Forestry and Fisheries, the municipalities concerned and the fishery cooperatives associations), the IAEA or other countries of the plan to discharge the contaminated water into the ocean.

At 16:00 the same day, TEPCO held a press conference to announce that it planned to discharge some of the contaminated water into the ocean as soon as the preparation got ready. At 18:30 the same day, TEPCO held another press conference to announce the planned time of the discharge into the ocean. In addition, Chief Cabinet Secretary Edano announced the plan for the water discharge into the ocean in a regular press conference held at 16:03 the same day. Furthermore, NISA also announced the plan for the water discharge into the ocean in an unscheduled press conference held at 16:25 the same day.

[Governmental Interim Report] Chapter V 6

9. Details of events in areas where there may be problems concerning the provision of information to the international community

(1) Provision of information concerning the discharge of contaminated water into the sea

a. Notification of the discharge of contaminated water into the sea to other countries and international organizations

As described above in 6 (1) e, TEPCO decided to discharge relatively less contaminated accumulated water into the sea with the consent of NISA on April 4. However, no staff at NISA who had been involved in the paperwork for the procedure required for the discharge recognized or pointed out the necessity of notifying related foreign countries. After it was decided that the discharge would be conducted, a staff member of NISA who was watching the Chief Cabinet Secretary's press conference that started at 16:03 on April 4 and recognized the need for notification, then visited the ERC to obtain the materials related to the discharge into the sea, and then notified the IAEA of the discharge via email at 17:46 the same day.

In addition, after 15:30 on April 4, a staff member of the Ministry of Foreign Affairs, who was at the Integrated Emergency Response Office, learned that TEPCO was planning to discharge the contaminated water into the sea and notified the related divisions within the Ministry about it. The news was communicated via email from a mobile phone to the staff member of the Ministry who was in charge of publication during the regular briefing that started at 16:00 the same day. The staff member notified the diplomats of the foreign countries of the news in the briefing. The discharge of the less contaminated water within the centralized waste disposal facilities actually started at 19:03 the same day. The Ministry of Foreign Affairs was notified of the planned discharge into the sea by the Ministry staff member who had been stationed at the Integrated Emergency Response Office, then informed all the diplomatic corps via email and fax that the discharge would begin that day. However, the notification stating that the discharge would begin that day was sent at 19:05 the same day after the discharge had already started at that time.

On April 5, the Ministry of Foreign Affairs and NISA again explained the details of the discharge of the contaminated water into the sea and its impact in the regular briefing that started at 16:00 (47 countries and two international organizations attended). Furthermore, on April 6, the Ministry of Foreign Affairs explained the details of the discharge and its impact to the embassies of South Korea, China and Russia located in Tokyo.

b. Question from the view point of the fulfillment of international commitment

As mentioned earlier in 6 (1) e (b), NISA concluded that the discharge of the less contaminated water into the sea conducted on April 4 did not have a significant impact on human health because the total effective dose rate had been evaluated to be 0.6mSv/year which was below the 1mSv/year value stipulated as the dose limit in the rules and notification about commercial reactors (see 4 (1) c above). The next day, on April 5, NISA enquired the Ministry of Foreign Affairs whether the discharge into the sea complied with the treaty, and received a response that said the discharge did not fall within the scope which requires notification prescribed in Article 2 of the Convention on Early Notification of a Nuclear Accident.

With regards to the obligation to notify prescribed in Article 198 of the United Nations Convention on the Law of the Sea, the Ministry of Foreign Affairs said, "the discharge does not correspond to the event 'in which the marine environment is in imminent danger of being damaged or has been damaged by pollution' prescribed in Article 198 of the United Nations Convention on

the Law of the Sea" and concluded that the discharge does not fall within the scope which requires Japan to notify other countries as stipulated in the Article. However, the Ministry of Foreign Affairs does not believe that there is no need for notification. Foreign Minister, Takeaki Matsumoto, said to the Committee of Foreign Affairs of the House of Representatives on April 13, "We should sincerely consider the problem presentation (from foreign countries) that requests detailed explanation in advance and also will make an effort to resolve the problem". Even if no notification obligation is stipulated in treaties, it is reasonable to consider that it is necessary to notify the related countries around Japan of the discharge in advance.

Furthermore, there are remarks that say it is not acceptable to discharge without any notification or consultation and Japan should get the agreement of neighboring countries on the discharge even if the concentration is rather low.

(2) Supply of information to other countries in the initial period after the accident

a. Framework of information provision to other countries

The Government held regular briefings regarding the Fukushima NPS accident in principle once a day during the period from March 13 to May 18 and three times a week after May 19 for the diplomatic corps residing in Tokyo. In the briefings, the explanation about the status and countermeasures regarding the accident was given by the staff who were in charge of the respective area and were mainly from the Foreign Ministry, but also from NSC, MEXT, the Ministry of Health, Labour and Welfare, the Ministry of Agriculture, Forestry and Fisheries, the Fishery Agency and NISA.

b. Information Provision to the USA after the accident occurred

The United States was greatly concerned about the status of the plant at the Fukushima NPS from the moment the accident had occurred. Although experts from the United States Nuclear Regulatory Commission (USNRC) and DOE contacted the agencies concerned to gather information, the United States could not get sufficient information. However, regular consultation between Japan and the US was initiated by the Prime Minister's Office on March 22, then the information and views regarding the plant were exchanged and the acceptance of relief supplies was coordinated during subsequent consultations. The consultation between Japan and the US significantly improved the flow of information regarding the plant for the US.

[Governmental Interim Report] Chapter V 9

10. Coordination with other countries and the IAEA

(1) Coordination with USA

As described above in 9 (2) b, the regular consultations initiated by the Prime Minister's Office on March 22 between Japan and the USA were attended by the DOE and the NRC of the US, the agencies concerned in Japan and TEPCO who shared and exchanged information and views regarding the plant and coordinated the acceptance of relief supplies.

During the consultations, there were many offers of cooperation such as the provision of barges that contained freshwater, stationing of US experts at the Integrated Emergency Response Office, integration of the results of monitoring analysis by the DOE and the SPEEDI analysis in Japan, and consultation about the use of remote controlled robots for monitoring and removing rubbles/debris.

(2) Support from other countries and Japan's response to their support

With regards to the offers of support from foreign countries regarding to the Tohoku District - off the Pacific Ocean Earthquake, the Ministry of Foreign Affairs mainly coordinated the recipients since the day the disaster had occurred.

With regards to the Fukushima NPS accident, various equipment was offered by foreign countries such as water pumps to use for the cooling of reactors, fire engines, barges containing freshwater, remote controlled robots, gamma cameras, protective clothing, protective masks, monitoring vehicles, aerial monitoring equipment, germanium semiconductor detectors and personal dosimeters.

Furthermore, protective clothing, rubber gloves and boots came soon after the middle of March, and several countries supplied those materials at the request of Japan.

On the other hand, the Government declined offers of equipment that required training on their operation before acceptance or equipment that was plentiful in Japan. For example, the offer to supply stable iodine was declined because there were large stocks of it in Japan and the storage and transportation of the stable iodine offered was expensive because it was in the form of liquid. Further, the offer of remote controlled unmanned robots was declined because it was necessary to be trained in their operation in the country supplying the robots. In addition, one country offered to supply monitoring vehicles; however the acceptance was delayed because it took a long time to secure drivers who could operate them.

The equipment offered by the USA was readily accepted because it was coordinated during the consultations between Japan and the USA in which the agencies concerned attended. Furthermore, since early April, the use of a "US-Japan Nuclear-Related Assistance Tracker" was proposed, which was an integrated at-a-glance format that represents information such as an explanation about the equipment that could be supplied, the destination of the equipment and the party who would accept them. This system lead to the acceptance of the relief supplies being more coordinated.

(3) Evacuation advice of foreign governments to their nationals in Japan

On March 16, the USA recommended USA citizens residing in Japan to evacuate from the area within a 50-mile (80km) radius of the Fukushima Dai-ichi NPS. The recommended evacuation distance of 50 miles was specified by the NRC on the basis of radiation dose for the worst-case scenario. In addition, that same day, the USA recommended the families of USA government staff to evacuate voluntarily from Japan.

On April 15, the USA withdrew their evacuation advice on March 16 for the families of USA government staff. Furthermore, on October 7, the evacuation area was decreased to a 20km radius from the 50-mile radius that had been specified on March 16.

Some countries other than the USA also published evacuation advice similar to that of the USA.

(4) Coordination with the IAEA

Article 2 Section 4 of the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency stipulates that signatory countries shall notify IAEA of experts, equipment and materials that could be made available to other signatories to assist them in the event of a nuclear accident or radiological emergency within the limits of their capabilities. On March 16, Japan asked the IAEA to provide information regarding items in the possession of other signatories such as remote controlled monitoring robots, aerial survey systems, unmanned trucks and unmanned helicopters. In response to this request, IAEA asked several countries to provide information about their respective equipment. The countries responded after March 17 and Japan accepted the equipment that those countries could supply such as the remote controlled robots.

[Governmental Interim Report] Chapter V 10

9. Details of Events in Areas where there may be Problems Concerning the Provision of Information to the International Community

(1) Provision of information to various countries

a. Press conferences by the Chief Cabinet Secretary and joint briefings

Since the nuclear accident, as part of the provision of information to other countries, the government took the measures such as: (i) simultaneous interpretation at the press conferences by the Chief Cabinet Secretary, (ii) briefings on the diplomatic corps in Tokyo by the Ministry of Foreign Affairs, and (iii) briefings to the foreign press by the Cabinet Public Relations Office of the Cabinet Secretariat (hereinafter referred to as the “Cabinet Public Relations Office”).

Firstly, since the evening of March 13, the government uploaded the English translation of the minutes of the press conferences by the Chief Cabinet Secretary on the website of the Prime Minister’s Office, and additionally, beginning with the press conference by the Chief Cabinet Secretary held at around 18:00 on March 16, the government introduced the simultaneous

interpretation of press conferences by the Chief Cabinet Secretary.

Next, the Ministry of Foreign Affairs, together with other relevant government ministries and agencies, including the NISA, held regular briefings on the diplomatic corps in Tokyo, in principle, once a day during the period from March 13 to May 18, and three times a week on May 19 onward.

Furthermore, the Cabinet Public Relations Office, together with other relevant government ministries and agencies, including the NISA, held briefings on the foreign press from March 21 through the end of 2011.

b. Responses to individual inquiries

In addition, the NISA and other relevant government ministries and agencies responded to individual inquiries from overseas.

After the declaration of a nuclear emergency at 19:03 on March 11, the Secretariat of the NERHQ was established at the ERC on the third floor of the METI's annex building, and the staff of the International Affairs Office of the Policy Planning and Coordination Division of the NISA, including the head of the Office who is in charge of the NISA's international public relations affairs, joined the ERC public relations squad, taking charge of the provision of information to other countries as well as responses to individual inquiries from foreign governments, etc.

The Cabinet Public Relations Office also responded to individual inquiries from the foreign press, etc.

c. Information Provision to the U.S. immediately after the accident occurred

(a) Provision of information from immediately after the accident until the start of Japan-U.S. consultations

The U.S. took strong interest in the situation of the accident at the Fukushima Dai-ichi NPS since immediately after the occurrence of the accident, and since March 12, U.S. government officials (including government officials in Japan, such as those at the U.S. embassy in Japan; hereinafter referred to just as the "U.S. side" without specifying their official titles or their individual names) repeatedly called Chief Cabinet Secretary Edano and other cabinet ministers stationed at the Prime Minister's Office or the staff of the Prime Minister's Office to offer U.S. support and seek the provision of information on the nuclear accident. In addition to the direct provision of information over the phone, the Japanese government explained the conditions of the reactors in the Ministry of Foreign Affairs on March 13, by phone calls from NISA Deputy Director-General Nishiyama before dawn on March 14, and within the METI during daytime the same day. However, in the evening of March 14, the U.S. side asked Chief Cabinet Secretary Edano for the further provision of information and the stationing of U.S. nuclear experts at the Prime Minister's Office. The U.S. side made the request apparently because they found the information provided by the Japanese government and Japan's system for disseminating information as still not sufficient. Chief Cabinet Secretary Edano withheld any immediate reply to the U.S. request at that stage because the U.S. intentions behind the request were not necessary clear.

Around that time, the U.S. Nuclear Regulatory Commission (NRC), while staying in close contact with NRC experts dispatched to the U.S. embassy in Japan, was considering the scope of an evacuation advisory it was planning to issue on its own to U.S. citizens in Japan, one of the reasons the U.S. was seeking detailed information from the Japanese government. However, the Japanese government was incapable of providing information to the U.S. in a manner satisfactory to the U.S. side, partly because the Japanese government was not made aware of such circumstances on the part of the U.S. and also because the information on the nuclear plant itself grasped by the Japanese government was not sufficient and officials of the NISA and other government staff familiar with the information on the nuclear plant were preoccupied with their work to deal with the plant's situation. This appears to be one of the reasons why the U.S. side was dissatisfied with the provision of information by the Japanese government.

Around March 15, the U.S. side again pressed Chief Cabinet Secretary Edano to accept the stationing of U.S. nuclear experts at the Prime Minister's Office, and after obtaining Prime Minister Kan's approval, Chief Cabinet Secretary Edano gave the go-ahead for NRC experts to be stationed at the Prime Minister's Office to gather information from March 16. Following this, METI staff and

NISA staff provided NRC experts with the information on the accident on the second floor of the Prime Minister's Office for several days from March 16.

Subsequently, for example, the U.S. side participated in a conference on the accident at the Fukushima Dai-ichi NPS that started at the Ministry of Defense on March 16 (from the Japanese side, officials of the Ministry of Foreign Affairs, the NISA, the Ministry of Defense and TEPCO participated), and before dawn on March 17, the U.S. side made another phone call to Chief Cabinet Secretary Edano, and came to the Integrated Headquarters on March 18 in their continued efforts to gather information.

(b) 50-mile evacuation advisory

As described in (a), the NRC was making attempts to collect information through various routes in order to consider the scope of the evacuation advisory it was planning to issue on its own to U.S. citizens in Japan. As the NRC failed to obtain sufficient information, it decided to issue the evacuation advisory from the safer side, and on March 17 (Japan time) advised U.S. citizens in Japan to evacuate outside of a 50-mile (about 80km) radius of the Fukushima Dai-ichi NPS. Amid the lack of sufficient information on the conditions of the nuclear power plants at the Fukushima Dai-ichi NPS, the evacuation advisory is understood to have been issued on the basis of the consideration that the radiation dose at a point 50 miles from the Fukushima Dai-ichi NPS was forecast to rise to around 1rem (10mSv).

(c) Commencement of Japan-U.S. Consultations

Around March 18, Special Advisor Hosono and House of Representatives Member Nagashima contacted the U.S. side at the Integrated Headquarters, etc. and the exchange of views with the U.S. side made them keenly aware of the need to unify the multiple channels for the provision of information to the U.S. side in order to provide accurate information to the U.S. side. Therefore, Special Advisor Hosono and other officials prepared a draft plan for the establishment of a mechanism of consultations between the Japanese and U.S. governments where relevant officials of the two governments get together to share information and coordinate the request for and acceptance of relief supplies (hereinafter referred to as the "Japan-U.S. Consultations"). After obtaining the approval of Prime Minister Kan, they started preparations for the first session of the Japan-U.S. Consultations. Around that time, Prime Minister Kan instructed Deputy Chief Cabinet Secretary Fukuyama to coordinate the views of the ministries and agencies concerned toward the launch of the Japan-U.S. Consultations and Special Advisor Hosono to administer the Japan-U.S. Consultations.

Subsequently, following a preparatory meeting between the U.S. side and the relevant Japanese ministries and agencies held on March 21, Deputy Chief Cabinet Secretary Fukuyama and Special Advisor Hosono convened the Japan-U.S. Consultations, starting on March 22. From the Japanese side, the consultations were joined by Deputy Chief Cabinet Secretary Fukuyama, Special Advisor Hosono and House of Representatives Member Nagashima, from the government side, and an official attached to the Assistant Chief Cabinet Secretary (for security and crisis management), officials from the relevant ministries and agencies, including the NSC, the Ministry of Foreign Affairs, the Ministry of Defense, the NISA, the MEXT, and TEPCO officials in charge. Thereafter, the sharing of information on the nuclear plants, exchanges of views and the coordination for the acceptance of relief supplies with the U.S. side were conducted at the Japan-U.S. Consultations. The status of information sharing between the Japanese and U.S. governments improved markedly through the Japan-U.S. Consultations, and the exchange of information among the relevant Japanese ministries and agencies came to be carried out more efficiently at meetings among the relevant ministries and agencies that preceded the Japan-U.S. Consultations.

(2) Provision of information concerning the discharge of contaminated water into the sea

a. Notification system based on the Convention on Early Notification of a Nuclear Accident

Under the METI's Nuclear Disaster Management Operation Manual, in the event of a nuclear accident that discharges radioactive materials, the Head of the International Affairs Office of the Policy Planning and Coordination Division of NISA is to make judgment on whether the accident

falls under the Convention on Early Notification of a Nuclear Accident and, if it does, notify the IAEA of the accident.

In response to the latest nuclear accident, the staff of the International Affairs Office of the Policy Planning and Coordination Division of the NISA (hereinafter referred to as the "NISA Staff Responsible for International Public Relations Activities"), including the Head of the International Affairs Office of the Policy Planning and Coordination Division of NISA, who is responsible for the notification under the Convention, as with the case at the time of the Integrated Nuclear Emergency Response Drill, did not have their desks within the ERC and provided information to other countries working out of the International Affairs Office of the Policy Planning and Coordination Division.

Thus, the NISA Staff Responsible for International Public Relations Activities and the ERC shared information on documents shared within the ERC by having the ERC send them to the International Affairs Office of the Policy Planning and Coordination Division. However, as the NISA Staff Responsible for International Public Relations Activities were not stationed at the ERC on a full-time basis, it was difficult for them to immediately take hold of information that is not documented.

b. Notification of the discharge of contaminated water into the sea to other countries and international organizations

As described in Chapter V 6. (1) e. of the Interim Report, TEPCO decided to discharge relatively less contaminated accumulated water in the centralized waste treatment facility into the sea with the consent of the NISA on April 4. However, no one among the NISA Staff Responsible for International Public Relations Activities was involved in the paperwork for the procedure required for the discharge and no NISA staff involved in the paperwork recognized or pointed out the necessity of notifying related foreign countries. One of the NISA Staff Responsible for International Public Relations Activities watching the Chief Cabinet Secretary's press conference that started at 16:03 on April 4 on TV learned of the planned implementation of the above-mentioned discharge for the first time and realized the need for notification, visited the ERC immediately to obtain the materials related to the discharge into the sea, and then notified the IAEA of the planned implementation of the discharge via email.

In addition, after 15:30 on the same day, a staff member of the Ministry of Foreign Affairs, who was at the Integrated Emergency Response Office, learned the plan to discharge the contaminated water into the sea and notified the related divisions within the Ministry about it. The news was communicated via email from a mobile phone to the staff member of the Ministry who was in charge of publication during the regular briefing that started at 16:00 the same day. The staff member notified the diplomats of the foreign countries of the news in the briefing.

The discharge actually started at 19:03 the same day. The Ministry of Foreign Affairs was notified of the planned discharge into the sea by the Ministry staff member who had been stationed at the Integrated Headquarters, and then informed all the diplomatic corps via email and fax that the discharge would begin that day. However, the notification was sent at 19:05 the same day after the discharge had already started.

On April 5, the Ministry of Foreign Affairs and the NISA again explained the details of the discharge of the contaminated water into the sea and its impact in the regular briefing that started at 16:00 (47 countries and two international organizations attended). Furthermore, on April 6, the Ministry of Foreign Affairs explained the details of the discharge and its impact to the embassies of People's Republic of China, the Republic of Korea (hereinafter referred to as South Korea) and Russia, located in Tokyo.

[Governmental Final Report] Chapter IV 9

The following isssues can be raised in association with communication to the public.

Communication to the public – spreading understanding of radiation effects

- The Government often explained, "It does not have immediate effects on health", concerning the influence of radiation on the human body. This expression may be interpreted by some people as "it is unnecessary to be anxious about the impact of radiation on human health," while it may be interpreted by other people as "it does not immediately affect human health, however, some effects on human health will appear in the longer term." However, it was not necessarily clear what the intended meaning of the expression was, and there was no detailed explanation. Moreover, anxiety regarding unknown nuclear disasters and dissatisfaction about the explanation from the government were broadly shared.

Communication to the public – comprehensibility of radiological protection system

- Residents who had to live in an environment contaminated by radioactive material after the accident sought information about the level of radioactivity that would serve as a basis for making decisions. Mothers, in particular, sought accurate information about the extent of contamination in the food and beverages they were giving their children, and about the radiation dose from the environment and its potential effects on their health. However, the information that was made available to the residents was not satisfactory.

Communication to the public – utilization of mass media

- The government rapidly responded to online communication by consolidating the relevant information onto its homepage and opening an official twitter account of the Cabinet. However, it used only one way communication such as mass media and could not provide appropriate timely information or gain the public's confidence, since the information was not obtained through bidirectional exchanges utilizing the characteristics of social media.

Communication to the public – response to foreign residents and overseas countries

- Although the discharge of the less contaminated water into the sea conducted on 4 April 2011 did not fall within the scope requiring notification prescribed in the United Nations Convention on the Law of the Sea, the notification stating that the discharge would begin was sent the day of discharge after it had already started and countries around Japan were not informed of the discharge in advance.

- The U.S. Nuclear Regulatory Commission (NRC) had been seeking detailed information regarding the status of the Fukushima Dai-ichi NPS from the Japanese government since 12 March 2011. However, the Japanese government was incapable of providing such information to the U.S. in a

manner satisfactory to the U.S. side, because Japanese government had not been able to acquire sufficient information on the nuclear power plant itself and officials of NISA and other government staff familiar with the situation at the nuclear plant were preoccupied with their work of dealing with the plant's situation. For this reason, the NRC decided to issue evacuation advice as a safety measure, and on 17 March (Japan time) advised U.S. citizens in Japan to evacuate to outside of a 50-mile (about 80km) radius of the Fukushima Dai-ichi NPS. This led to confusion because this radius for evacuation was significantly larger than the 20km radius of the Japanese evacuation area.

(6) Nuclear emergency preparedness

(a) Nuclear emergency preparedness system and responses of relevant organization after accident

Nuclear emergency preparedness and the response of the relevant organization have been pointed out in the all investigative reports from various viewpoints. However the responses of the relevant organization have been already described in the above issues selected. For this reason, to avoid overlapping of the descriptions, **[National Diet Report]** that describes the overview of the nuclear emergency preparedness, was referred in the following way.

3.2.1 The government's organizational framework at the time of the nuclear disaster

The government's nuclear emergency preparedness system assumes that after a declaration of a nuclear emergency situation (Nuclear Emergency Declaration) is issued, the NERHQ and the Local NERHQ, which is established at the Off-site Center, serves as the core, and, with other relevant organizations, works together and cooperates in their response to a nuclear accident.

1. Organizational framework in the event of nuclear disaster

The government's preparedness system in the event of a nuclear disaster is prescribed in detail under the Nuclear Emergency Preparedness Act, the Basic Plan for Emergency Preparedness and the Nuclear Emergency Response Manual (NER Manual), etc.

According to the NER Manual, etc., the NERHQ and the Local NERHQ are the core organizations that respond to a nuclear disaster. When the prime minister issues a Nuclear Emergency Declaration, the NERHQ (for which the prime minister serves as the director-general) should be established at the Kantei and the Local NERHQ at the Off-site Center. The director-general of the Local NERHQ, to whom the director-general of the NERHQ delegates part of his/her authority, undertakes the response to the accident, including the issuance of evacuation orders, in accordance with the actual local conditions and with the support of the NERHQ and the support and cooperation of the other relevant organizations such as municipal governments (see Figure 3.2.1-1).

In order to facilitate coordination among these organizations, the Integrated Nuclear Emergency Preparedness Network was formed among the Kantei, the METI Emergency Response Center (NISA-ERC), where the secretariat of the NERHQ is established, the Off-site Center, and the Cabinet Office's Nuclear Safety Commission (NSC), an organization that advises on responses to nuclear accidents. Information and communication equipment, including the videoconference

system, was in place to enable an exchange of information on a real-time basis.

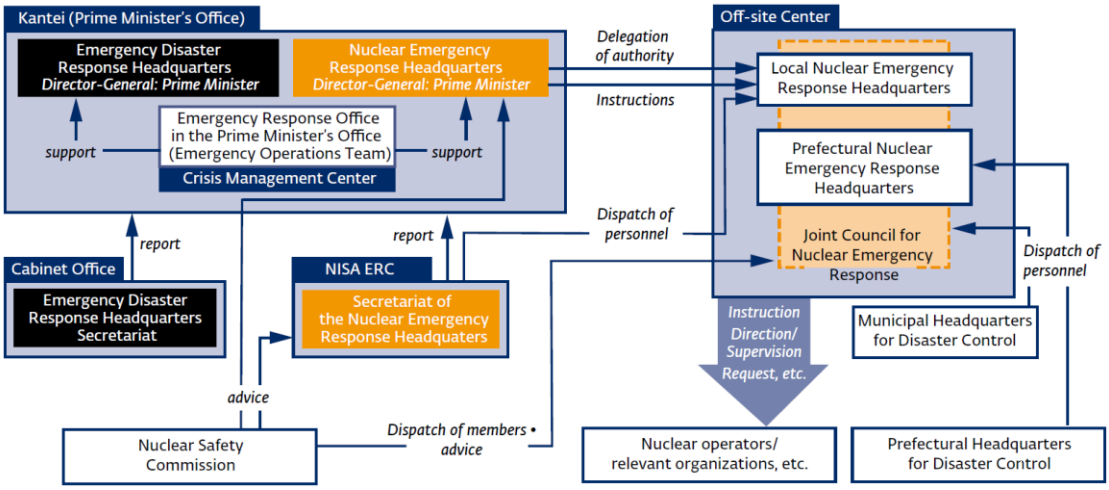


Figure 3.2.1-1 Outline of the organizational framework concerning the nuclear emergency preparedness (in the case of this accident)

2. Impact of earthquake disasters, etc. on the nuclear emergency preparedness system

The abovementioned nuclear emergency preparedness system had been built on the assumption that the infrastructure, including communication and transportation networks, would function and operate as in ordinary times; the loss of the functions of this infrastructure was not amply anticipated and countermeasures for such a situation had not been adequately taken in advance. The earthquake and its aftermath disasters that preceded this accident impacted or damaged the facilities and equipment, significantly hampering the emergency response by the government and other organizations from the time immediately after the earthquake.

a. Disruption/confusion of communication networks

The earthquake and its aftermath disrupted a large part of the ground communication circuits in Fukushima Prefecture. This made communications between the government, the Disaster Provision Main Office of Fukushima Prefecture (the Prefectural Headquarters for Disaster Control) and other relevant organizations in Fukushima Prefecture, including the Off-site Center, extremely difficult. It also became almost impossible to retrieve data on environmental radiation dose measurements from monitoring posts set up by the Fukushima prefectural government.

In Fukushima Prefecture, a large proportion of the municipal disaster management radio communication lines for use by the Prefectural Headquarters for Disaster Control were rendered unusable, resulting in a significant loss of communication capacity with municipal governments and other relevant organizations.

The general public circuits (including cell phones) experienced communication failures due to a huge increase in communications traffic in the metropolitan Tokyo region immediately following the earthquake. Preference circuits for use in the event of a disaster also reached their capacity, disrupting communications for relevant organizations that depended on these means of communication.

b. Disruption/confusion of transportation networks

The disruption and confusion faced by transportation networks following the earthquake and its aftermath created significant obstacles to transportation from Tokyo to Fukushima Prefecture as well as to transportation within Fukushima Prefecture. This resulted in a major delay in assembling necessary personnel at the Off-site Center.

c. Impact on other facilities

The earthquake also damaged the emergency generator at the Off-site Center, causing a delay in

starting up the Off-site Center.

[National Diet Report] Chapter 3, 3.2.1

3.2.2 The status of the core organizations for responses to the accident

The cornerstones of the government's emergency response system are the NERHQ, the secretariat of the NERHQ, and the Local NERHQ. The NERHQ and its secretariat were responsible for the monitoring of the nuclear facilities conditions, and as liaison for coordinating emergency response measures, such as the evacuation of residents. They were unable to perform those anticipated roles, largely because the secretariat of the NERHQ failed in the function of collecting and sharing information concerning the progression of the accident and the progress of the response, and partly because the Kantei stepped in to lead the government's response to this accident. In addition, the Local NERHQ could not take the initiative in the on-site response to the accident, such as issuing evacuation orders, because it was not prepared, either for the simultaneous occurrences of an earthquake, tsunami and nuclear accident, or for such a prolonged and serious accident.

1. NERHQ

a. Role

According to the Nuclear Emergency Preparedness Act, the NERHQ is an organization that is temporarily established in the cabinet office after the prime minister issues a Nuclear Emergency Declaration, for the promotion of emergency response measures and the comprehensive coordination among relevant organizations. In the event of a nuclear power plant accident, the prime minister serves as the director-general of the NERHQ and the Minister of Economy, Trade and Industry (METI Minister) serves as the deputy directorgeneral. According to the NER Manual, the secretariat of the NERHQ is to be established at the safety regulatory ministry/agency for nuclear facilities where an accident occurs. In the case of this accident, the secretariat of the NERHQ was established at NISA-ERC.

b. Confusion caused by a decision-making process different from that in drills

In the annual comprehensive nuclear emergency preparedness drills, the secretariat of the NERHQ collects and sorts out information from nuclear power plants, etc. Based on that, the NERHQ and/or the Local NERHQ decide on protective measures, and the secretariat of the NERHQ and/or the Local NERHQ give instructions for countermeasures to the relevant parties.

During this accident, the NERHQ held a total of eight meetings in the early phase of the accident between March 11 and March 15. However, the core organization for the emergency response was not the NERHQ, but the prime minister and other concerned parties who assembled in the prime minister's office and reception rooms on the fifth floor of the Kantei (the fifth floor of the Kantei). As the situation of the events evolved so fast, as described in detail in 3.4.1, there was no time for discussion at these meetings of the NERHQ, and thus the fifth floor of the Kantei directly collected opinions and views from TEPCO, NISA, the members of NSC and other parties concerned, and made decisions based on them.

2. Secretariat of the NERHQ (NISA-ERC)

a. Role

The secretariat of the NERHQ for this accident was established at NISA-ERC and was expected to perform the functions of planning and coordinating responses to the accident being undertaken by the NERHQ, the Local NERHQ, and other relevant organizations. More specifically, the secretariat was responsible for the collection of information on nuclear plants, the forecasts, monitoring results and other information of the dispersion of radioactive materials, and for the planning of protective measures for residents (including evacuation orders) and the coordination, etc. of emergency transportation of supplies, on the basis of such information. In particular, in the early stage before the establishment of the Local NERHQ, the secretariat of the NERHQ, instead of the Local NERHQ, was expected to perform the key role in the government's response to the accident. (For example, when the NERHQ issues evacuation orders to relevant municipalities, the secretariat is to promptly

prepare draft orders and propose them to the director-general of the NERHQ.)

In order to perform these roles, NISA-ERC had, among its facilities necessary for emergency response measures, a videoconference system connected to the conference room of the Kantei (where NERHQ meetings were held), NSC, the Off-site Center and other relevant organizations, as well as multiple data display terminals of the Emergency Response Support System (ERSS) and the System for Prediction of Environmental Emergency Dose Information (SPEEDI). In terms of staff, necessary personnel was dispatched from relevant ministries and agencies, including the Cabinet Secretariat, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) and the Ministry of Health, Labour and Welfare (MHLW), who were to facilitate the coordination of emergency response measures with the organizations from which they were dispatched, including evacuation guidance.

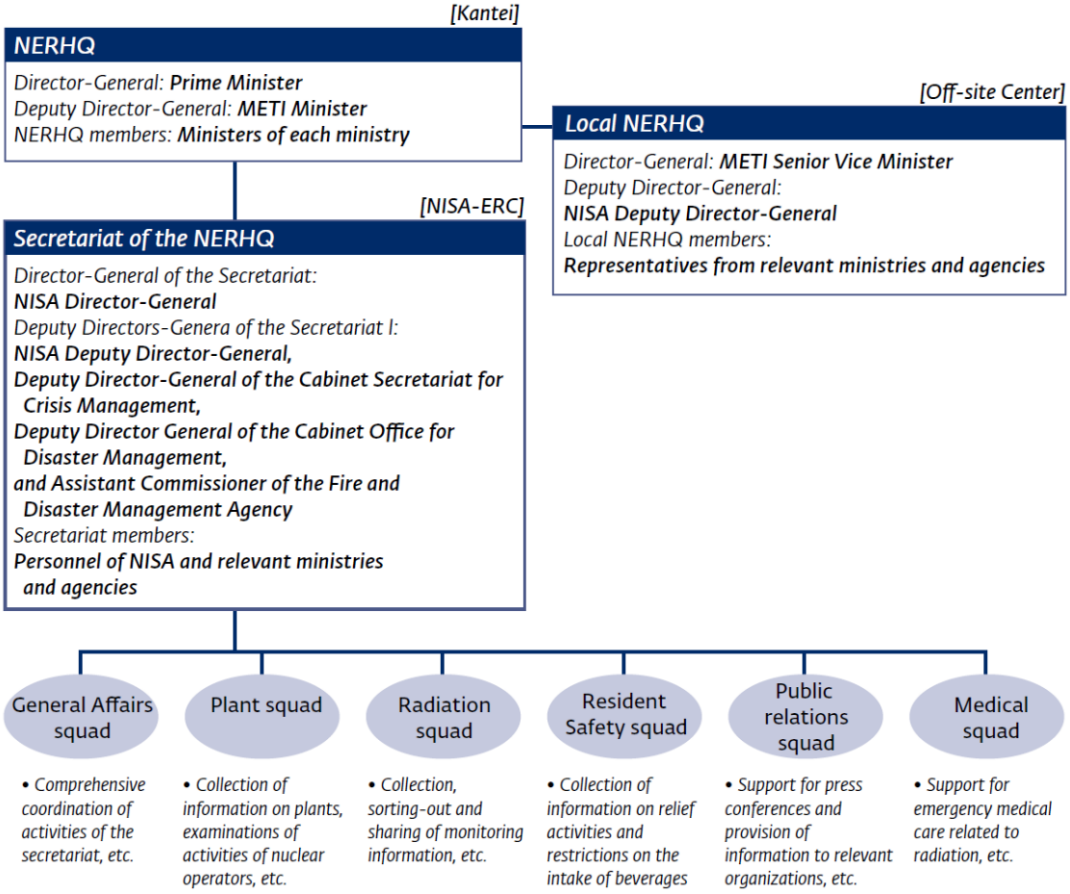


Fig. 3.2.2-1 Composition of the secretariat of the NERHQ in this accident

b. Inadequate information collection

The loss of all the AC power supply at the Fukushima Daiichi Nuclear Power Plant stopped the ERSS data transmission server, disabling the predictive calculations by ERSS of the amounts and the timing of the release of radioactive materials to the atmosphere outside the plant and the prediction calculations by SPEEDI of the dispersal of radioactive materials based on the ERSS calculations.

In addition, sufficient information about the accident site of the Fukushima Daiichi Nuclear Power Plant could not be obtained as expected. The plant's nuclear safety inspectors from the office of nuclear safety inspectors, who were to perform the role of information gathering, were visiting the plant for safety inspections when the earthquake occurred. These safety inspectors, except for those necessary to set up the Off-site Center, stayed at the accident site. However, they could not collect enough information as TEPCO employees were involved with the emergency response. As the means of communication with the outside was quite limited, all the safety inspectors left for the

Off-site Center around 4:00 on March 12. Thus, the secretariat of the NERHQ lost the means to directly collect information from the accident site, including how TEPCO was responding to the situation.

On March 13, at the instruction of the METI Minister, safety inspectors again visited the Fukushima Daiichi plant, checked the plant's preparedness system, etc. for the water injection work, and reported the inspection results to the Local NERHQ. However, they collected information only from within the Seismic Isolation Building. All the safety inspectors, who feared for their physical safety due to the deterioration of the situation—including the explosion at the Unit 3 building and the rising pressure in the pressure vessel and other facilities of Unit 2—evacuated to the Off-site Center by the evening of March 14, with the approval of the head of the office of nuclear safety inspectors. This again resulted in the loss of any means to directly collect information from the accident site.

At the Off-site Center, TEPCO brought its in-house videoconference system into the company's booth soon after the recovery of the power supply and established the conditions for real-time communication with the TEPCO Emergency Response Center at TEPCO's head office and the TEPCO Emergency Response Center at the Fukushima Daiichi Plant, etc. However, partly because the Off-site Center's communication facilities had been substantially damaged, the Local NERHQ never reported the detailed content of the communications of TEPCO's videoconference system to the secretariat of the NERHQ.

The secretariat of the NERHQ collected information on the accident site only through faxes sent from TEPCO and inquiries made to the TEPCO Emergency Response Center at TEPCO's head office by TEPCO staff dispatched to the secretariat. The secretariat of the NERHQ received a large number of faxes from TEPCO, but was aware that this method of information collection was time-consuming, and lacking in necessary information. However, bound by the notion formed in ordinary times that there should be a clear line drawn between the safety regulatory agency and nuclear operators, the secretariat never took more proactive steps to improve its information-gathering system, such as dispatching its staff to the TEPCO Emergency Response Center at TEPCO's head office to collect information.

c. Inadequate provision of information to other relevant organizations

In accordance with the NER Manual, relevant ministries and agencies were to send necessary personnel to the secretariat of the NERHQ. In the initial response immediately after this accident, however, some ministries and agencies failed to dispatch personnel to the secretariat, stating their response to the earthquake and tsunami disasters as the reason. While the secretariat of the NERHQ provided information to relevant organizations, mainly by fax, in many cases information transmitted by fax was not written in jargon-free style for officials without special or technical knowledge about nuclear power. Officials at the relevant organizations who received faxed information often could not understand the gravity of the situation, or were at a loss about how to handle the received information, and thus there were some cases where the officials failed to share it within the relevant organizations.

d. Responses to this accident that fell behind the curve

As NISA was tied up with the emergency response, the Cabinet Secretariat took over the general and clerical affairs of the NERHQ via a cabinet decision. The Cabinet Secretariat and NISA then reached an understanding that substantive work should be undertaken by NISA.

However, confronted with the unexpected dysfunction of the Local NERHQ as well as the inadequate collection and sharing of information as mentioned above, the secretariat of the NERHQ had no choice but to fall behind the curve in considering and implementing response measures to the nuclear accident. Regarding the evacuation of residents, for example, though the secretariat of the NERHQ was considering possible areas for the evacuation, the fifth floor of the Kantei decided, before the secretariat of the NERHQ had reached any specific conclusion, on an order for the evacuation of residents within a 3km radius of the Fukushima Daiichi plant. The same thing happened with an order for the evacuation of residents within a 10km radius of the plant. The members of the secretariat of the NERHQ, after learning that the evacuation areas had already been

decided upon without their involvement, and despite their intent to provide necessary information in advance of such a decision, gradually came to assume the passive attitude of acting on instructions from the Kantei. In its response to the accident other than the designation of evacuation areas, there is no evidence that the secretariat of the NERHQ ever made any effective proposals to the Kantei.

Thus, the secretariat of the NERHQ became an organization that took only ex-post facto or passive action, such as relaying information on decisions by the fifth floor of the Kantei regarding evacuation orders to the municipal governments concerned, and sending information obtained from TEPCO to the Kantei.

3. Local NERHQ (Off-site Center)

a. Role

The Local NERHQ is designed as an organization to take the initiative in the government's emergency response measures and activities locally in the event of the issuance of the Nuclear Emergency Declaration. The Local NERHQ is established at the Off-site Center (the center for emergency response measures) and organizes the Joint Council for Nuclear Emergency Response (Joint Council) with the prefectural/municipal headquarters for disaster control of the nuclear facility location, for purposes of information exchange and mutual cooperation.

An Off-site Center is designated for each nuclear facility as a base for responding to a nuclear disaster. They were positioned to act as the base of the nuclear emergency preparedness system by the Emergency Nuclear Preparedness Act, enacted in December 1999 in response to problems that came to the fore in the wake of the accident at JCO Co., Ltd.

Relevant ministries and agencies, as well as governments of prefectures and municipalities where nuclear facilities are located, send personnel to Off-site Centers as staff to engage in disaster response operations. Off-site Centers are also equipped with communication lines necessary for their operations, videoconference systems connected to NISA-ERC and other relevant organizations, and terminals of ERSS and SPEEDI. In order to smoothly carry out the disaster response, the director-general of the NERHQ delegates, as necessary, part of his/her authority concerning orders to evacuate residents, restrict the intake of beverages and food and the intake of stable iodine tablets, etc. to the director-general of the Local NERHQ (or, in the case of a nuclear power plant accident, the METI Senior Vice Minister).

For the Fukushima Daiichi plant and the Fukushima Daini plant, the Fukushima Prefectural Nuclear Emergency Response Center, located adjacent to the Environmental Radioactivity Monitoring Center of Fukushima Prefecture in Okuma Town, was designated as the Off-site Center.

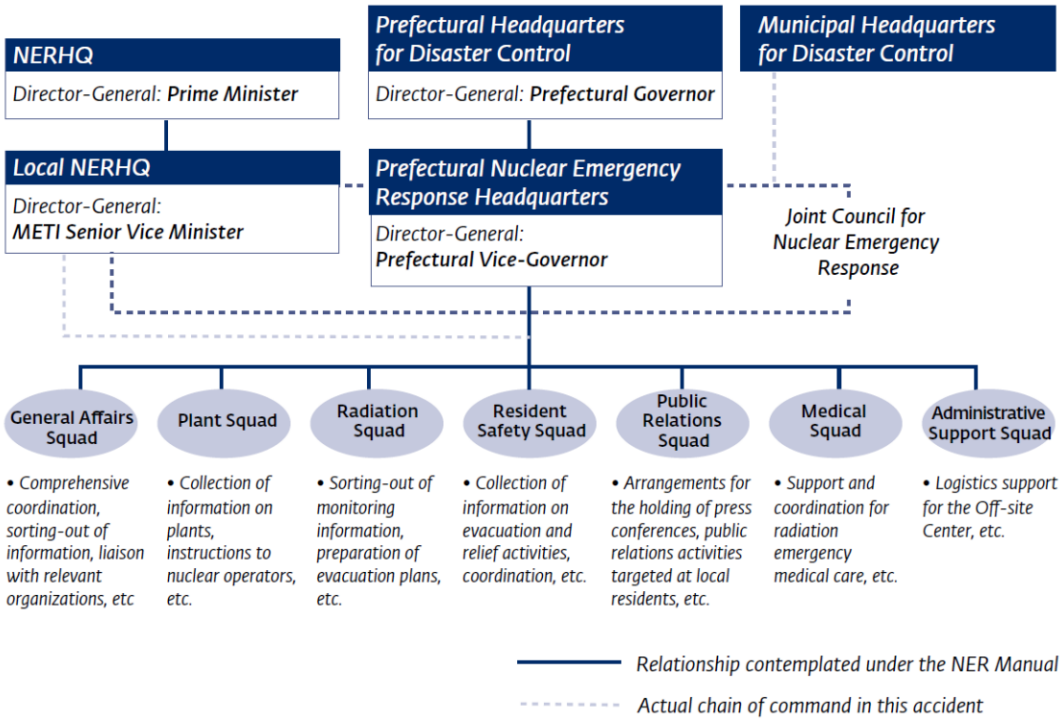


Fig. 3.2.2-2 Composition of organizations of the Off-site Center in this accident

b. Problems with the establishment of the Off-site Center

The establishment of the organizations that needed to be set up at the Off-site Center for this accident required a lot of time due to the delays and cancellations of the arrivals of necessary personnel (including the director-general of the Local NERHQ), as well as the earthquake's impact on facilities and equipment.

The towns that host the nuclear facility did not dispatch personnel, as they were tied up with their response to the earthquake and tsunami disasters. The one exception was Okuma Town, where the Off-site Center was located.

METI Senior Vice Minister Ikeda (who was to serve as the director-general of the NERHQ) and other METI and NISA officials who were to be dispatched, left METI for the Off-site Center by car around 16:00 on March 11, immediately after the earthquake, but were stranded on their way, caught in traffic jams caused by the earthquake. They decided to go to the Off-site Center using an Self-Defence Force helicopter, but due to the limit on the number of people who could board, only a few people, including Ikeda and the NISA Deputy Director-General (who was to serve as the deputy directorgeneral of the Local NERHQ), could actually head for the Off-site Center. People dispatched by the Fukushima prefectural government also required a lot of time to arrive at the Off-site Center because of road damage caused by the earthquake. These people arrived at the Off-site Center at around midnight on March 12, more than five hours after the issuance of the Nuclear Emergency Declaration.

When they arrived at the Off-site Center, however, it was totally without power, as the earthquake had damaged its emergency generator. Therefore, the dispatched personnel temporarily went to the Environmental Radioactivity Monitoring Center of Fukushima Prefecture, but could not do much in terms of their expected activities. The effective establishment of the Local NERHQ was delayed until around 3:00 on March 12, when the emergency generator at the Off-site Center resumed normal operations.

As described above, the Off-site Center could not perform any of its functions during the period immediately after the occurrence of this accident, and therefore made no contributions whatsoever to the emergency response at that time.

c. Problems with the operation of the Off-site Center

At the Off-site Center, even after the restoration of the power supply, ground communication lines such as for the videoconference system, telephones and fax machines remained disconnected. The Off-site Center's communication with the outside relied entirely upon a few satellite phones, causing serious problems with the sharing of information, liaison and coordination with relevant organizations. In particular, because the nuclear facility-hosting towns except for Okuma Town failed to dispatch personnel to the Off-site Center as described above, little information was shared with those towns.

Due to the disruption of communication lines, it became impossible to obtain information on plants, ERSS or SPEEDI, making it extremely difficult for the Off-site Center to devise measures to protect residents.

Though the information collected by the Local NERHQ was meant to be regularly announced or released at press conferences at the Off-site Center, such opportunities never came, as no media visited the Off-site Center after this accident. The directorgeneral of the Local NERHQ and other dispatched personnel made efforts to perform their respective roles. The director-general of the Local NERHQ was engaged in operations such as issuing instructions to prepare for the intake of stable iodine tablets, for example, though it was then not necessarily clear whether the director-general of the NERHQ had actually delegated part of his authority to the director-general of the Local NERHQ. However, as the situation at the Off-site Center was quite different from what had been planned, the organizations at the Off-site Center were unable to adequately perform their respective roles designated legislation including the Nuclear Emergency Preparedness Act.

d. The prolongation and increasing seriousness of the situation and the relocation of the Off-site Center

Following the expansion of the evacuation zone beyond a 10km radius of the Fukushima Daiichi plant, the Off-site Center, located within a 5km radius of the plant, became isolated in the evacuation zone. It became difficult to procure fuel, food and other necessary supplies.

As the Off-site Center was not equipped with air filters to block the penetration of radioactive materials, radiation doses within the building increased in tandem with the rises in radiation doses in surrounding areas, raising concerns about the impact on the health of personnel there. Under these circumstances, the Local NERHQ, after consultations with the secretariat of the NERHQ, decided to relocate the functions of the Off-site Center to a location outside the evacuation zone. However, the Fukushima Prefectural Government Minamisoma Office (located in Minamisoma City), the alternate site, was occupied by the Soso District Development Bureau of the Fukushima prefectural government as a headquarters mainly for response measures for the earthquake and tsunami disasters, which left no space for the Off-site Center. Eventually, on March 15, it was decided to relocate the Off-site Center to the Fukushima prefectural government building.

The director-general of the Local NERHQ and its staff made efforts to perform their respective roles, and recorded their daily activities even amid the heights of confusion in which they found themselves. This deserves the Commission's recognition and acclaim. However, as the situation of the Off-site Center was completely different from what had been anticipated, the Off-site Center could not take sufficient measures to protect the local residents.

After its relocation to the Fukushima prefectural government building, the Local NERHQ gradually restored its expected functions and energetically undertook operations for local residents. It also solicited requests for measures from people affected by the nuclear accident and conveyed them to the government.

e. Inadequate assumptions about the complex disaster and the prolongation and seriousness of the nuclear accident

As described above, the Off-site Center was forced to relocate after failing to adequately perform its expected functions. This largely resulted from the fact that the Offsite Center did not have logistical support and personnel in place on the basis of full assumptions about the possibilities of complex disasters, the simultaneous occurrences of earthquake/tsunami disasters and a nuclear disaster, and a situation of prolonged and grave seriousness, as witnessed in this accident. However, it had at least been pointed out as a result of the administrative evaluation/monitoring by the

Ministry of Internal Affairs and Communications (MIC) in February 2009 that measures would be needed to reduce exposure to doses of radiation within the Off-site Center in the event of a nuclear accident. Nonetheless, NISA failed to take adequate measures, concluding that no further measures were needed as long as the measure was secured of the Off site Center building to be well sealed to get less air circulation (air-tightness), and that the installation of air filters was not necessary.

[National Diet Report] Chapter 3, 3.2.2

3.2.3 Status of organizations supporting the emergency response

This section examines whether the planned assistance was provided to the core organizations in charge of emergency response noted in the previous section. Examined in this section are the Emergency Response Office in the Prime Minister's Office, which was responsible for the initial response following a nuclear accident, NSC, which was to provide technical and expert advice, and MEXT, which was in charge of measuring the effects of radiation and developing forecasting systems in order to examine protective measures for local residents.

To summarize, confusion was seen within the Emergency Operations Team of the Emergency Response Office in the Prime Minister's Office during its simultaneous response to the disasters, which included the earthquake and tsunami as well as the nuclear accident, but the team quickly proceeded with general coordination and decision-making of the relevant organizations. However, many problems were observed at NSC, which was unable to provide collective advice as an organization, and at MEXT, which failed to fully utilize the systems and tools it had developed to ascertain the status of the diffusion of radioactive material.

1. Emergency Response Office in the Prime Minister's Office (Crisis Management Center)

a. Role

The Crisis Management Center has been established and developed as part of the Cabinet's initiatives to strengthen its crisis management functions. The center was set up in 1995 in the wake of the Hanshin-Awaji Earthquake and the sarin gas attack on Tokyo's subway; it developed further in response to incidents such as the 1996 Japanese embassy hostage crisis in Peru and the 1997 grounding and oil spill of a Russian oil tanker. Located in the basement of the Kantei, the center includes a conference room for executive officials and an operations room to cope with a variety of situations.

The center also has visual-image, communication and information processing system for gathering and analyzing information, as well as a network linked to relevant government ministries and agencies. The center ensures security through measures that prevent the leakage of radio waves and a strict access screening system.

The November 21, 2003 Cabinet Decision "Regarding the Government's Initial Response Framework for Emergencies" stipulates that the Deputy Chief Cabinet Secretary for Crisis Management is to establish an Emergency Response Office in the Prime Minister's Office,whenever an emergency occurs and quickly convene an Emergency Operations Team consisting of director-general-level members from each government ministry and agency at the Crisis Management Center to gather information relating to the government's initial response.

The Emergency Response Office in the Prime Minister's Office was meant to engage in the initial response following the outset of a nuclear disaster up to the point when the NERHQ begins full-fledged operations. Once the activities of NERHQ and its secretariat begin in earnest, it is assumed that operations will be handed over to the secretariat of the NERHQ. However, the relationship between the Emergency Response Office in the Prime Minister's Office and the secretariat of the NERHQ was not clearly defined in the NER Manual.

b. The response by the Emergency Response Office in the Prime Minister's Office to this accident

The Emergency Response Office in the Prime Minister's Office was established at 14:50, four minutes after the earthquake struck at 14:46 on March 11, 2011. Initially, the Emergency Response Office in the Prime Minister's Office was charged with responding to the earthquake and tsunami

disaster.

Following the notice from TEPCO about the occurrence of an event coming under Article 15 of the Nuclear Emergency Preparedness Act, METI Minister Kaieda reported to Prime Minister Kan, requesting that a Nuclear Emergency Declaration be issued; when doing so, however, the discussions between the Director-General of NISA and the Deputy Chief Cabinet Secretary for Crisis Management and other officials that were stipulated in the NER Manual were not undertaken. The Deputy Chief Cabinet Secretary for Crisis Management and other officials did not even attend the petition procedure for Prime Minister Kan. This is believed to have been caused by the unclear nature of the NER Manual, and a lack of understanding on the part of executive officials and staff in charge at NISA regarding the details of the procedure whereby the Emergency Response Office in the Prime Minister's Office, among others, was to be involved, since related persons from the Emergency Response Office in the Prime Minister's Office and the Emergency Operations Team had not participated in annual comprehensive nuclear emergency preparedness drills.

After NERHQ was set up, the operation room within the Crisis Management Center began its full-fledged emergency response by separating activities into two booths: one predominantly focused on the response to the earthquake and tsunami disaster; the other predominantly focused on the response to the nuclear disaster. The politicians in the Kantei, including Prime Minister Kan, moved to a small room on the mezzanine floor and then to the area surrounding the Office of the Prime Minister on the fifth floor of the Kantei, because the operation room was in an uproar and they were not comfortable making decisions in such a place. This caused a disruption in the flow of information with the Crisis Management Center.

c. Relationship with the Emergency Response Office in the Prime Minister's Office and the secretariat of the NERHQ (NISA-ERC)

The Emergency Operations Team gathered at the Emergency Response Office in the Prime Minister's Office consisted of director-general level members from related government ministries and agencies who had a certain degree of decision-making authority. The Team had been convened on several past occasions in the wake of natural disasters and was accustomed to responding to emergencies. As a result, the coordination between related government ministries and agencies for the response to this accident was, in general, performed promptly.

However, there were problems concerning information sharing with NERHQ. Originally, nuclear plant information was to be gathered at the secretariat of the NERHQ in the ERC and conveyed to NISA personnel dispatched to the Emergency Response Office in the Prime Minister's Office. Plans also called for this information to be shared with the Kantei as well. In this accident, however, as has been mentioned above, the secretariat of the NERHQ was unable to sufficiently collect information (including plant information) about the site. In addition, NISA executive officials were responding to the secretariat of the NERHQ and the fifth floor of the Kantei, making it impossible for NISA, unlike the other government ministries and agencies, to permanently place executive officials in the Emergency Operations Team. Therefore, the Emergency Response Office in the Prime Minister's Office was unable to smoothly collect nuclear plant information, so it requested TEPCO head office to dispatch TEPCO employees, and it started collecting information on the nuclear plant. Incidentally, the first and second reports related to the explosion at Unit 1 of the Fukushima plant, made by a police officer of the Fukushima Prefectural Police, were conveyed to the Kantei via the National Police Agency. Given this, a sense of distrust of and malcontent with NISA gradually began to take hold in the members of the Emergency Operations Team gathered at the Emergency Response Office in the Prime Minister's Office.

2. The Nuclear Safety Commission (NSC)

a. Role

As an expert body on nuclear power in the nuclear emergency preparedness activities, NSC is to provide appropriate advice based on requests made by the director-general of NERHQ, or the prime minister. According to the Basic Plan for Emergency Preparedness, when NSC receives a notification pursuant to the provision of Article 10 from the operator, NSC is to set up a headquarters organization called an emergency technical advisory body within its secretariat, as

well as a local body of the emergency technical advisory body at the Off-site Center to which it will dispatch, among others, the NSC commissioners and the advisors for emergency responses. In turn, NSC is to collect information and perform investigations and analyses, as well as prepare technical advice.

b. Delay in establishing an emergency technical advisory body

NSC used the group e-mail system for mobile phones to summon the advisors for emergency responses and attempted to establish an emergency technical advisory body. However, the group e-mail was not delivered to some advisors for emergency responses, and disruptions in public transportation and telecommunications meant that nearly all of the advisors for emergency responses that were summoned failed to convene on March 11. During the initial response, members of NSC and advisors for emergency responses were not dispatched to the site, nor were any local body established at the Off-site Center.

NSC participated in the comprehensive nuclear emergency preparedness drills organized by the government and practiced procedures for establishing an emergency technical advisory body by implementing its own nuclear emergency preparedness drills. However, NSC had not anticipated the disruptions in public transportation or telecommunications that occurred as a result of this earthquake and tsunami, which caused the delay in establishing the emergency technical advisory body.

c. Unpostulated work demanded by the Kantei

According to the NER Manual, NSC is supposed to provide advice regarding technical matters on the implementation of emergency response measures when requested to do so by the prime minister, who also serves as the director-general of NERHQ.

NSC Chairman Madarame and NSC Secretary General Akihiko Iwahashi attended the first meeting of NERHQ from19:03 on March 11, 2011, following a request made by the Kantei. After the meeting ended, Madarame returned once to NSC Secretariat, but he returned again to the Kantei at its request. From then on, he was almost continuously stationed at the Kantei until around March 15, involved in discussions held on the fifth floor. NSC Deputy Chairman Yutaka Kukita also headed to the Kantei to sit in on the second meeting of NERHQ, and at the request of Madarame, he remained almost continuously assigned to the Kantei until around March 15 in order to aid the Chairman.

On the fifth floor of the Kantei, Madarame and Kukita offered advice grounded in technical expertise, based on the plant information that had been collected. However, this advice was not offered as advice from NSC as an organization, but merely represented personal views in their capacity as members of NSC. NSC is an advisory body that uses the collective knowledge of its five expert members to provide advice. As a result, this type of immediate on-the-spot response to requests for advice had not been assumed. With the prolonged absence of two of its five members as well as its secretary general, NSC was significantly impaired from functioning as an organization.

d. Broad range of advisory requests and consultations

NSC is required to provide technical advice in response to requests received from the director-general of NERHQ and relevant organizations, but rules had not been clearly stipulated on the target themes and methods for delivering this advice.

As a result, after this accident, the Secretariat for NSC was overwhelmed by a wide range of advisory requests, consultations and questions from numerous public offices, primarily including the Ministry of Agriculture, Forestry, and Fisheries (MAFF), the Ministry of Health, Labour, and Welfare (MHLW), the Ministry of Education, Culture, Sports, Science and Technology (MEXT) and the Ministry of the Environment (MOE). Included among these were questions that went beyond the expertise of NSC, such as “What will happen if migratory birds fly from Fukushima to Tokyo?” and “We’ve had local residents evacuate, but what do we do about livestock?” Many other questions did not necessarily regard technical matters, such as “How should we handle the bodies of tsunami victims that have been exposed to radiation?” Members and staff remaining at the Secretariat were busy responding to these questions. NSC had never assumed these types of

advisory requests or questions, and the workload exceeded NSC's capacity.

3. The Ministry of Education, Culture, Sports, Science and Technology (MEXT)
a. Role

According to the MEXT Emergency Action Plan, MEXT must establish a Nuclear Emergency Response Support Headquarters within the ministry when an event occurs at an METI-administered facility as designated in Article 10 or 15 of the Nuclear Emergency Preparedness Act.

According to MEXT's Nuclear Emergency and Disaster Response Manual, the Nuclear Emergency Response Support Headquarters exists mainly to provide advice for monitoring conducted by the Off-site Center radiation squad, to analyze monitoring data, and to dispatch disaster medical assistance teams to the site.

b. Insufficient monitoring support

According to the Basic Plan for Emergency Preparedness, MEXT and other relevant organizations are to dispatch personnel and equipment to local governments to support emergency monitoring activities undertaken by the local governments.

In this accident, most of the monitoring posts set up by Fukushima Prefecture were damaged in the earthquake or tsunami and were unusable. On March 12, MEXT decided to dispatch monitoring vehicles and personnel to the Off-site Center. Three monitoring vehicles, one general vehicle used for monitoring and monitoring personnel arrived on site on March 13, and MEXT's support team began monitoring activities on March 15. Support provided by MEXT did not take into account the extended duration of the situation, which resulted in a shortage of fuel and other supplies for the monitoring vehicles. When the Local NERHQ moved to the Fukushima Prefectural Government Building on March 15, the team was forced to leave the monitoring vehicles that had run out of fuel at the Off-site Center.

The emergency monitoring assumed prior to the accident was not carried out, so on the morning of March 16 at the Kantei, duties were assigned, mainly by Chief Cabinet Secretary Edano. MEXT was placed in charge of compiling, and NSC was charged with assessing, the data from emergency monitoring conducted outside a 20km radius of the Fukushima Daiichi plant.

MEXT had planned to begin airborne monitoring from the predawn hours of March 12, but these plans were not implemented until much later. After coordinating with the Ministry of Defence (MOD), an MOD helicopter was placed on standby to conduct airborne monitoring on March 12, but a miscommunication prevented MEXT personnel from boarding and the monitoring opportunity was lost. In the end, airborne monitoring was conducted on March 25 with the cooperation of the Japan Aerospace Exploration Agency (JAXA).

c. Failure to utilize airborne monitoring data provided from overseas

After March 18, 2011, airborne monitoring data gathered by the United States Department of Energy using US military aircraft was conveyed to MEXT and NISA via the Ministry of Foreign Affairs of Japan (MOFA). MEXT failed to share this data with NSC or the Kantei because it considered the data to be the results of monitoring performed by the United States, and thus it was not responsible for compiling such data. If it had been conveyed to the fifth floor of the Kantei, this data could have been used as a reference when protective measures were devised for local residents.

[National Diet Report] Chapter 3, 3.2.3

3.5.1 Initial response by Fukushima Prefecture

Fukushima Prefecture's nuclear emergency preparedness system was set forth in the nuclear emergency response section of the Fukushima Prefecture regional disaster prevention plan. The plan, however, did not assume a nuclear emergency resulting from an earthquake or other natural disaster.

1. Fukushima Prefecture's organizational structure for nuclear emergencies

Fukushima Prefecture's organizational structure for times of nuclear emergency was laid out in the nuclear emergency response section of the Fukushima Prefecture regional disaster prevention

plan.

The nuclear emergency response section stipulates that, if a notification is received in accordance with Article 10 of the Nuclear Emergency Preparedness Act, a Prefectural Headquarters for Disaster Control is to be established at the Fukushima Prefectural Government offices (Main office) and the Prefectural Nuclear Emergency Response Headquarters is to be formed at the Off-site Center. It further indicates that nine squads (general affairs, information gathering, communications, public relations, external affairs, activity support, aid, supplies, and resident evacuation and safety) are to be established under the Prefectural Headquarters for Disaster Control, and information gathering is to be conducted and assistance is to be provided to municipal governments for resident evacuation.

In addition to the nuclear emergency response section, the Fukushima Prefecture regional disaster prevention plan also has an earthquake response section. This section notes that the national government has confirmed the seismic safety of the nuclear power plants (the Fukushima Daiichi Nuclear Power Plant and the Fukushima Daini Nuclear Power Plant), and that an earthquake is not assumed to cause a nuclear emergency. In other words, the regional disaster prevention plan was not formulated on the presumption that a natural disaster such as an earthquake would spawn a nuclear emergency. The earthquake response section does set forth the organizational structure for earthquakes; however, this structure assumes a plan based on the same nine functional squads as set forth in the nuclear emergency response section.

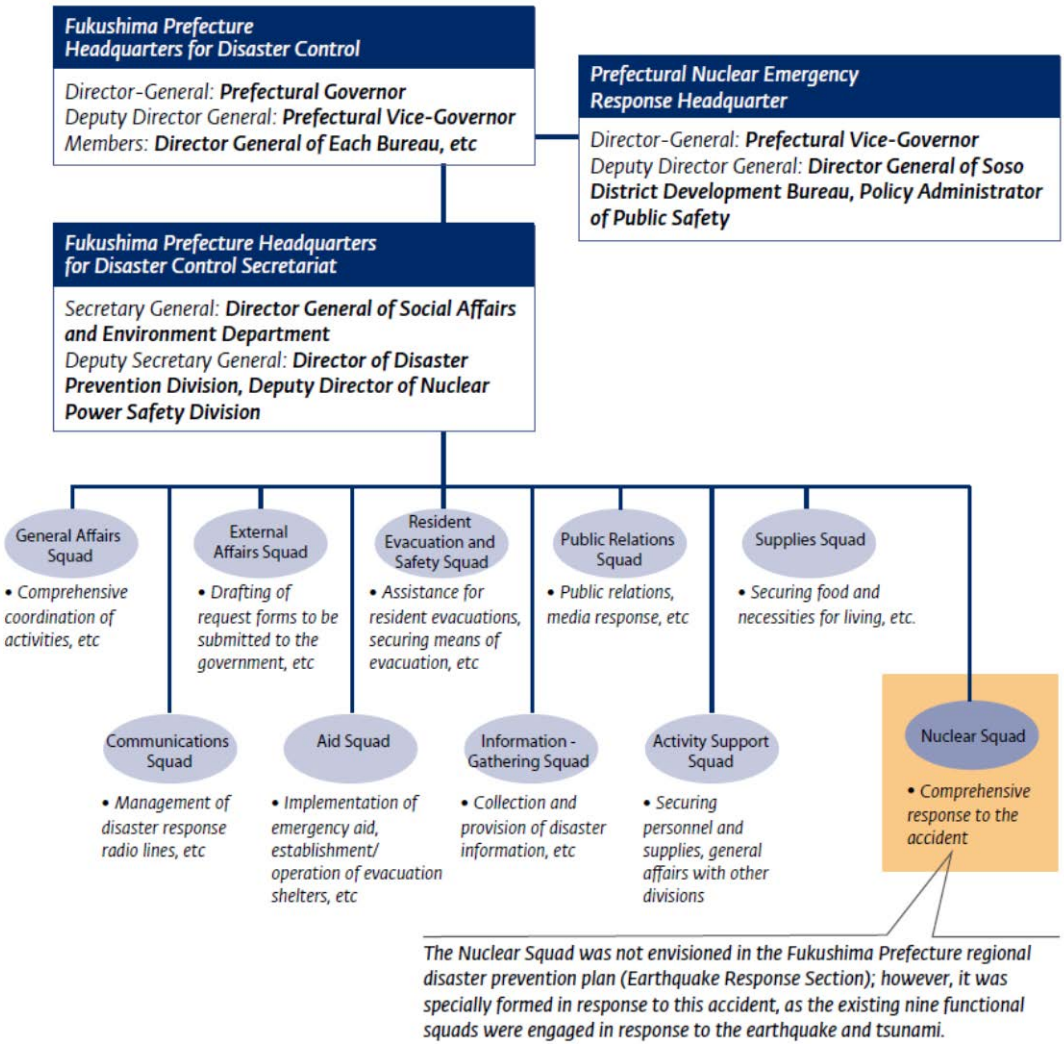


Figure 3.5.1-1 Initial organizational structure of the Fukushima Prefecture Headquarters for Disaster Control

2. Initial response

a. Structure of the earthquake- and tsunami-focused Headquarters for Disaster Control

When the nuclear accident happened, a large number of personnel at the Fukushima Prefectural Office were working on the various functional squads at the aforementioned Fukushima Prefecture Headquarters for Disaster Control, in accordance with the earthquake response section of the Fukushima Prefecture regional disaster prevention plan, in order to implement earthquake and tsunami countermeasures. For this reason, the number of personnel available to respond to the nuclear disaster was significantly limited, making it impossible to implement the structure laid out in the nuclear response section of the regional disaster prevention plan.

Fukushima Prefecture therefore hastily established a new squad, which was devoted to the nuclear disaster response, placed under the organizational structure set forth in the earthquake response section. However, the squad's staffing was limited and the squad was forced to respond to nuclear power and radiation issues single-handedly without any clearly defined scope of operations.

Officials in the nuclear squad were, though, under the impression that the response to the nuclear disaster was mainly to be carried out at the Off-site Center, and the ineffectiveness of the Off-site Center thus pushed the prefecture's response to the disaster into a state of confusion. The Fukushima Prefecture Headquarters for Disaster Control had to oversee operations that it had not foreseen, including, for instance, securing truck-mounted generators requested by TEPCO and screening evacuated residents.

b. Disabled prefectural government buildings and loss of communications

The Fukushima Prefecture regional disaster prevention plan stipulates that the Fukushima Prefecture Headquarters for Disaster Control is to be established on the fifth floor of the main office of the prefectural government building. However, the main office of the prefectural government building was constructed in 1954 and its seismic resistance was low. The prefecture was aware of the office's unpreparedness for an earthquake and had planned anti-seismic reinforcement construction, but at the time of the disaster, improvements had yet to be made. So the main office of the prefectural government building was completely disabled by the earthquake, making it impossible to establish the Fukushima Prefecture Headquarters for Disaster Control. The division in charge of nuclear emergency preparedness-related matters, which was to bear the central role in responding to this accident, was based at West wing of the prefectural government building, which was also difficult to use due to anti-seismic issues.

Fukushima Prefecture then transferred the necessary equipment to the third floor of the Fukushima Prefecture Public Hall, a building designated in the regional disaster prevention plan as an alternate facility in the event that the main office of the prefectural government building could not be used. It was there that the Fukushima Prefectural Government set up the Fukushima Prefecture Headquarters for Disaster Control. This building, however, only had two municipal disaster management radio communication lines—a vital communication network during times of emergency—whereas the main office of the prefectural government building was equipped with 47. Communication networks between the prefectural and municipal governments and other agencies were fragile, a major obstacle in responding to damage caused by the earthquake and tsunami as well as the nuclear disaster. The municipal disaster management radio communications are important during times of any disaster, not only nuclear emergencies. Fukushima Prefecture's risk awareness can be considered lacking—budgetary restrictions aside—as anti-seismic reinforcements were not prioritized for the building planned for the Headquarters for Disaster Control and an adequate number of the municipal disaster management radio communication lines were not allocated to the substitute facility.

The Fukushima Prefectural Police Headquarters had also designated the main office of the prefectural government building as the location for establishing a disaster security center during times of disaster, with the Fukushima Prefectural Police Office as a substitute facility. The Fukushima Prefectural Police Office, however, had already installed communications facilities on par with facilities at the main office of the prefectural government building. There was therefore no significant inconvenience with communications during the initial stages following the accident.

c. Ineffectiveness of the Prefectural Nuclear Emergency Response Headquarters

Following the disaster, Fukushima Prefecture dispatched personnel to an Off-site Center and established the Prefectural Nuclear Emergency Response Headquarters but the officials were unable to fulfill their assumed role.

In past comprehensive nuclear emergency preparedness drills, a scheme was assumed where at the Off-site Center, discussions would take place at the Prefectural Nuclear Emergency Response Headquarters to compile the intentions of the prefectural government, which were to be coordinated with the municipal and national governments in the Joint Council for Nuclear Emergency Response. However, as events unfolded quickly in this accident, no substantial discussions took place in the Prefectural Nuclear Emergency Response Headquarters and the Joint Council for Nuclear Emergency Response.

Moreover, the Prefectural Nuclear Emergency Response Headquarters personnel were limited at all times to three or four people, and, particularly after March 14, as the personnel were tied up in preparation to transfer the Off-site Center to the Fukushima Prefectural Government office, it was difficult to implement emergency response measures, taking into account the actual situation of prefectural residents.

[National Diet Report] Chapter 3, 3.5.1

3.5.2 Fukushima Prefecture's response to resident evacuations

The Fukushima Prefectural Government and the national government were not aware of each other's respective situations following the nuclear power plant accident. Feeling a sense of crisis, Fukushima Prefecture took its own initiative to issue an evacuation order for a radius of 2km from the Fukushima Daiichi Nuclear Power Plant. Thirty minutes later, however, the national Government issued an evacuation order for residents within a 3km radius of the plant. It was extremely difficult to disseminate information to the residents due to the shortage of the municipal disaster management radio communication lines and the damage to communications equipment resulting from the earthquake and tsunami.

1. Evacuation order given at the discretion of Fukushima Prefecture

Fukushima Prefecture, acting on its own accord, issued an evacuation order for residents within 2km of the nuclear power plant at 20:50 on March 11, approximately 30 minutes before the national government's decision to set the evacuation area to a 3km radius around the Fukushima Daiichi Nuclear Power Plant.

The Fukushima Prefecture Headquarters for Disaster Control had acquired information from TEPCO and was aware that the situation at the Fukushima Daiichi Nuclear Power Plant was quickly deteriorating. However, it took approximately two hours after TEPCO notified the national government before the declaration of a nuclear emergency situation was issued, pursuant to Article 15 of the Emergency Preparedness Act. Fukushima Prefecture was not notified of the declaration of a nuclear emergency situation for nearly one and a half hours following the declaration. Although the prefecture was aware that it did not have clear legal grounds for issuing an evacuation order, they sensed danger in the national government's failure to issue evacuation orders and decided to issue a resident evacuation order on their own for a 2km radius around the Fukushima plant. The 2km radius was determined by the prefecture as the bare minimum distance considering the 2km evacuation radius used for residents in past comprehensive nuclear emergency preparedness drills.

When issuing its 2km evacuation zone radius, the prefecture was unaware that the national government was also considering evacuation zones. The prefecture did not notify the national government that it had issued the evacuation orders, and only 30 minutes later, at 21:23, the national government issued evacuation orders for a 3km radius around the nuclear power plant without knowing prefecture's evacuation orders.

2. Difficulty disseminating information about the evacuation orders

After issuing the 2km radius evacuation order, Fukushima Prefecture held a press conference for

reporters at the Fukushima Prefecture Headquarters for Disaster Control, and then communicated the evacuation orders to municipal governments and residents using the Fukushima Police radio and regional fire department radio.

The municipal disaster management radio communications that were ordinarily supposed to serve as an important means of communicating information to municipalities did not work due to a shortage in the number of available lines, and communications equipment at some of the municipal offices was damaged by the earthquake and tsunami. These factors made it tremendously difficult for the prefecture to communicate the evacuation orders to the municipal governments.

[National Diet Report] Chapter 3, 3.5.2

The following isssues can be raised in association with nuclear emergency preparedness system and responses of relevant organization after accident.

Nuclear emergency preparedness system – preparedness for complex disasters

- Serious confusion occurred in the relevant organization owing to insufficient preparedness for an accident scenario where events unfold quickly and for facing a complex disaster involving earthquakes and tsunamis occurring simultaneously with a nuclear disaster.

  - The central organization of the government's emergency response system is the NERHQ (the Prime Minister and the Minister of Economy, Trade and Industry (METI) serve as the director-general and the deputy director-general, respectively). The secretariat of the NERHQ was established at NISA-ERC and was expected to monitor the nuclear facilities' conditions and coordinate emergency response measures, such as the evacuation of residents. They were unable to perform those anticipated roles, largely because the secretariat of the NERHQ failed to collect and share information concerning the progression of the accident and the progress of the response, and partly because the Kantei (the Prime Minister and other concerned parties who assemble in the prime minister's office and reception rooms on the fifth floor of the Kantei) stepped in to lead the government's response to this accident as the situation of the accidental events evolved extremely rapidly.

  - The Local NERHQ (the deputy minister of METI serves as the director-general), to which the NERHQ delegates part of its authority, is responsible for the response to the accident, including the issuance of evacuation orders, in accordance with the actual local conditions and with the support of the NERHQ and the support and cooperation of the other relevant organizations such as municipal governments. The establishment of the organizations that needed to be set up at the Off-site Center (the center for emergency response measures) for this accident required much time owing to the delays and cancellations of the arrivals of necessary personnel (including the director-general of the Local NERHQ), as well as the earthquake's impact on facilities and equipment. The effective establishment of the Local NERHQ was delayed until around 3:00 on 12 March, when the emergency generator at the Off-site Center resumed normal operations. Feeling a sense of crisis, Fukushima Prefecture took its own initiative to issue an evacuation order for a radius of 2km from the Fukushima Dai-ichi NPS. Thirty minutes later, the national government issued an

evacuation order for residents within a 3km radius of the plant. In this emergency situation, the Off-site Center failed to adequately perform its expected functions.

- Following the expansion of the evacuation zone beyond a 10km radius of the Fukushima Dai-ichi NPS, the Off-site Center (located within a 5km radius of the plant) became isolated in the evacuation zone, making it difficult to procure fuel, food and other necessary supplies. As the Off-site Center was not equipped with air filters to block the penetration of radioactive materials, radiation doses within the building increased in tandem with the rises in radiation doses in surrounding areas, and on 15 March, it was decided to relocate the Off-site Center to the Fukushima prefectural government building.

- The Emergency Response Office in the Prime Minister's Office (Crisis Management Center) was meant to engage in the initial response following the outset of a nuclear disaster up to the point when the NERHQ begins full-fledged operations. Once the activities of NERHQ and its secretariat began in earnest, it was assumed that operations would be handed over to the secretariat of the NERHQ. However, the politicians in the Kantei, including Prime Minister Kan, moved to a small room on the mezzanine floor and then to the area surrounding the Office of the Prime Minister on the fifth floor of the Kantei, because the operation room was in uproar and they were not comfortable making decisions in such a place. This caused disruption in the flow of information with the Crisis Management Center.

- As an expert body on nuclear power in the nuclear emergency preparedness activities, NSC is meant to provide appropriate advice based on requests made by the director-general of the NERHQ, or the prime minister. According to the Basic Plan for Emergency Preparedness, NSC is to set up a headquarters organization, called an emergency technical advisory body, within its secretariat, as well as a local body of the emergency technical advisory body at the Off-site Center to which it will dispatch the NSC commissioners and the advisors for emergency responses. In turn, NSC is to collect information and perform investigations and analyses, as well as prepare technical advice. However, owing to disruptions in public transportation and telecommunications, nearly all of the advisors for emergency responses that were summoned failed to convene on 11 March. During the initial response, members of NSC and advisors for emergency responses were not dispatched to the site, nor were any local bodies established at the Off-site Center.

- After the NSC Chairman attended the first meeting of NERHQ on 11 March 2011, following a request made by the Kantei, he remained almost continuously assigned to the Kantei until around 15 March, together with the NSC Deputy Chairman, and offered advice grounded in technical expertise, on the basis of the plant information that had been collected. However, this advice was not offered as advice from NSC as an organization. With the prolonged absence of two of its five members as well as its secretary general, NSC was significantly impaired in its function as an organization.

- According to the MEXT Emergency Action Plan, MEXT must establish a Nuclear Emergency Response Support Headquarters within the ministry, mainly to provide advice for monitoring conducted by the Off-site Center radiation

squad, to analyze monitoring data, and to dispatch disaster medical assistance teams to the site. MEXT and other relevant organizations are to dispatch personnel and equipment to local governments to support emergency monitoring activities undertaken by the local governments. On 12 March 2011, MEXT decided to dispatch monitoring vehicles and personnel to the Off-site Center, but the MEXT's support team did not begin monitoring activities until 15 March. Owing to a shortage of fuel and other supplies for monitoring vehicles, when the Local NERHQ moved to the Fukushima Prefectural Government Building on 15 March, the team was forced to leave the monitoring vehicles that had run out of fuel at the Off-site Center.

- A Prefectural Headquarters for Disaster Control was to be established at the Fukushima Prefectural Government offices (Main office fifth floor) and the Prefectural Nuclear Emergency Response Headquarters was to be formed at the Off-site Center. Nine squads were to be established under the Prefectural Headquarters for Disaster Control to gather information and provide assistance to municipal governments for resident evacuation. However, a large number of personnel at the Fukushima Prefectural Office were working on the various functional squads at the Fukushima Prefecture Headquarters for Disaster Control, in order to implement earthquake and tsunami countermeasures. Fukushima Prefecture therefore hastily established a new nuclear squad, which was devoted to the nuclear disaster response. However, responses of the nuclear squad fell into a state of confusion owing to the ineffectiveness of the Off-site Center. The Fukushima Prefecture Headquarters for Disaster Control had to oversee operations that it had not foreseen, including, for instance, securing truck-mounted generators requested by TEPCO and screening evacuated residents.

- The main office of the Fukushima prefectural government building, established as the Fukushima Prefecture Headquarters for Disaster Control, was due to undergo anti-seismic reinforcement construction because its seismic resistance was low, but at the time of the disaster, improvements had yet to be made. Fukushima Prefecture then transferred the necessary equipment to the third floor of the Fukushima Prefecture Public Hall, a building designated as an alternate facility. This building, however, only had two municipal disaster management radio communication lines-a vital communication network during times of emergency-whereas the main office of the prefectural government building was equipped with 47. Communication networks between the prefectural and municipal governments and other agencies were fragile, which created major obstacles in responding to damage caused by the earthquake and tsunami as well as the nuclear disaster.

- Following the disaster, Fukushima Prefecture dispatched personnel to an Off-site Center and established the Prefectural Nuclear Emergency Response Headquarters, but the officials were unable to fulfill their assumed role. This was because no substantial discussions took place in the Prefectural Nuclear Emergency Response Headquarters and the Joint Council for Nuclear Emergency Response, particularly after 14 March, since the personnel were occupied with preparations to transfer the Off-site Center to the Fukushima Prefectural Government office as events unfolded quickly in this accident.

(b) Opportunity of revision of nuclear emergency preparedness for complex disasters (earthquake, tsunami, and nuclear accident)

Descriptions about opportunity of revision of nuclear emergency preparedness for complex disaster are given in **[Governmental Interim Report]**, **[National Diet Report]** and **[Nongevernmental Report]** in the following way.

6. Response to nuclear emergency in the midst of complex disaster

(1) History of the initiatives of the Japanese government and local governmental organizations to address the risk of nuclear accident happening in the context of a complex disaster

The question of how one should respond to a nuclear emergency initiated by an earthquake came into focus following the occurrence of fire at the Kashiwazaki-Kariwa NPS when it was struck by the Niigata-ken Chuetsu-oki Earthquake in 2007. The government of Niigata Prefecture, where the given NPS exists, pursued a unique approach to disaster prevention. For example, the prefectural government added a chapter on a complex disaster to its Regional Disaster Prevention Plan for Nuclear Emergency Preparedness.

Upon requests from the Niigata prefectural government, the national government requested the investigation committee on the above-mentioned accident at the Kashiwazaki-Kariwa NPS to examine and report on the issue of preparedness against a nuclear emergency coupled with a complex disaster. The report produced by the investigation committee stated the government's intention to sort out by the end of fiscal 2008, under the leadership of NISA, the issues that require attention when responding to a nuclear emergency in a complex disaster. In April 2009, NISA submitted "A Draft on the Issues Requiring Attention When Preparing an Emergency Response Manual for Nuclear Emergency Coupled with Complex Disaster" at the sixteenth meeting of the Nuclear Emergency Preparedness Subcommittee of the Nuclear and Industrial Safety Subcommittee under the Advisory Committee on Natural Resources and Energy.

However, the draft document stated that the probability of a nuclear emergency being coupled with a complex disaster was extremely small, based on the view that nuclear power facilities employ a seismic structural design and are technologically well protected against earthquakes on a design basis level, and also based on the view that the incident that had taken place at the Kashiwazaki-Kariwa NPS as a result of the Niigata-ken Chuetsu-oki Earthquake fell short of being a nuclear emergency. Therefore, the draft document concluded that it was reasonable to develop countermeasures on the basis of ongoing organizational arrangements for disaster prevention and negated the need to make new organizational arrangements for disaster prevention assuming the possible occurrence of a nuclear emergency coupled with a complex disaster.

Moreover, the draft document received criticisms such as the following, which argued against the very act of developing countermeasures against a nuclear accident coupled with a complex disaster, from concerned agencies of the national government and local governmental organizations:

(i) The development of countermeasures against a nuclear emergency in a complex disaster may become a cause of the mistaken view that major natural disasters are likely to initiate a nuclear emergency;

(ii) The implementation of countermeasures against a nuclear emergency in a complex disaster will require major modifications to regional disaster prevention plans, etc.; or

(iii) For affairs to be handled by an organization other than NISA, there has not been sufficient negotiation with concerned organizations.

In response to such criticisms, NISA in October 2010 affirmed the view that the probability of a nuclear emergency being initiated by a natural disaster is virtually zero, and finalized the policy that countermeasures against a complex disaster should be pursued within the ongoing scheme for disaster prevention. From then on, up to the occurrence of the Fukushima nuclear accident, NISA did not discuss countermeasures against a nuclear emergency coupled with a complex disaster.

In October 2008, in Fukushima Prefecture, a comprehensive drill for preparedness against a nuclear emergency, which had been conducted annually in pursuant to the Act on Special Measures Concerning Nuclear Emergency Preparedness, the Basic Disaster Prevention Plan, etc., was

conducted in conjunction with an emergency preparedness drill organized by the prefectural government. The scenario used in the drill assumed a failure in the emergency cooling system, etc., at Unit 3 of the Fukushima Dai-ichi NPS causing the loss of cooling capability and core damage. It was assumed that basic infrastructures, such as roads and telecommunication links, remained available.

Besides the above, the Fukushima prefectural government was independently conducting drills for preparedness against a nuclear emergency on an annual basis, and also was conducting independently drills on specific subjects such as the evacuation of residents and the conducting of monitoring activities. The Fukushima prefectural government tried in many ways to improve the practical significance of these drills by inviting citizens to participate in evacuation drills and by choosing not to let the participants know about the scenario in advance. However, none of these drills assumed the combination of a nuclear accident and an earthquake, which eventually became a reality.

In contrast, learning lessons from the accident that had happened at the Kashiwazaki-Kariwa NPS as a result of the Niigata-ken Chuetsu-oki Earthquake, the Niigata prefectural government was considering since May 2010 beginning evacuation drills assuming the simultaneous occurrence of an earthquake and a nuclear emergency. In the same month, NISA told the Niigata prefectural government that conducting a drill assuming the coupling of a nuclear emergency with an earthquake of seismic intensity of Level 5 weak (JMA scale) might spread anxiety and misunderstanding among local citizens. After having internally discussed this opinion of NISA, the Niigata prefectural government decided not to assume an earthquake.

However, in a drill for preparedness against a nuclear emergency that the Niigata prefecture government organized in November of the same year, the combination of heavy snowfall and a nuclear disaster was assumed in a complex disaster scenario.

(2) Difficulty encountered in responding to the accident because it happened in the context of a complex disaster

In the case of the Fukushima nuclear accident, damage caused by the earthquake was not limited to destructive damage to the plant itself such as the failure of reactor cooling systems that resulted from the impact of the tsunami. Activities conducted in response to the accident had to deal with great difficulties that ensued from the earthquake and tsunami, such as a shortage of manpower and the impairment of telecommunication and transportation infrastructures.

As to the manpower shortage, the national government was not fully able to ensure sufficient availability of manpower because it had to deal simultaneously with very widespread earthquake damage and a nuclear emergency. The local governments of affected areas also faced the problem of limited manpower because they had to take care of residents who suffered damage from the earthquake and tsunami while administering nuclear emergency response measures such as evacuation and body decontamination.

As to the impairment of communication infrastructure, telephone, facsimile and other means were not readily available for use due to the earthquake. In conducting emergency response activities, there arose difficulty in the sharing of information and communication among concerned organizations. It should be noted that the off-site center (Local Emergency Response Center), which had been expected to play a key role in the emergency by centrally managing information and leading emergency response activities, was hardly able to fulfill its purpose because the headquarters, before being relocated to the Fukushima Prefectural Office on May 15, 2011, had no other means of telecommunication than satellite phones.

As to the impairment of transport infrastructure, heavy traffic congestion ensued from the earthquake in metropolitan areas, which prevented the smooth delivery of fire engines, water lorries, battery carrying trucks, power supply vehicles, etc., on their way to the Fukushima Dai-ichi NPS and caused delays in the delivery of necessary equipment. This is one of the major causes that prevented the prompt execution of emergency response activities. The traffic problem delayed the assembling of members at the off-site center (Local Nuclear Emergency Response Headquarters) and then continued to interfere with the activities of the Local Nuclear Emergency Response Headquarters by causing a shortage of fuel and food. The poor condition of road traffic caused

difficulty also to monitoring and evacuation activities.

Since the simultaneous occurrence of a nuclear emergency and a natural disaster was not anticipated, we assume that these problems had not been given attention and therefore had entirely been left without being addressed by corresponding measures. We believe that these problems could have been avoided or at least alleviated if corresponding measures had been prepared and drills had been conducted on the basis of sound assumptions on various events that might ensue from an earthquake or accident.

[Governmental Interim Report] Chapter VI 6

4.3.2 Insufficient disaster preparedness against complex disasters

The expansion of damage caused by this accident is attributed to the insufficient preparedness on the part of the central government and municipal governments in facing a complex disaster involving earthquakes and tsunamis occurring simultaneously with a nuclear disaster.

The Niigata-ken Chuetsu-oki Earthquake, which occurred on July 16, 2007, triggered multiple troubles and failures, including a transformer fire and a leakage of water containing radioactive substances at the Kashiwazaki-Kariwa Nuclear Power Plant. In response to these outcomes, many pundits requested nuclear power plants to put emergency preparedness measures in place to address complex disasters. However, no integrated efforts had been made by the central government and municipal governments to establish disaster preparedness against complex disasters prior to the accident at the Fukushima Daiichi plant.

Please note that "complex disaster" is used in this section to refer to an event whereby a nuclear disaster occurs simultaneously or in line with a natural disaster, including an earthquake. The term will subsequently be used according to this definition unless otherwise defined.

1. Initiatives to rework disaster preparedness structures based on the Regional Disaster Prevention Plan

a. Roles of the Regional Disaster Prevention Plan

The Regional Disaster Prevention Plan defines how prefectural and municipal governments should deal with nuclear disasters. It is created by each local government in line with the Basic Plan for Emergency Preparedness defined by the Central Disaster Prevention Council established in the Cabinet Office.

NISA once worked on a policy allowing municipal governments hosting nuclear power plants to modify their Regional Disaster Prevention Plans to make them ready for complex disasters. This move, however, had not come up with any effective results, partly because of objections voiced by related agencies of the central government and some local governments hosting nuclear power plants, prior to the time of this accident.

b. Planning based on the assumption that complex disasters are not likely to occur

The occurrence of the Niigata-ken Chuetsu-oki Earthquake in 2007 prompted a number of local governments hosting nuclear power plants, including Niigata Prefecture, to request various agencies of the national government, such as NISA, to implement measures in preparation for complex disasters (including situations where a nuclear power plant is, or could be, affected by a large-scale natural disaster).

Niigata Prefecture made an issue of the fact that the national government and the electricity companies had no mechanism in place to provide information to municipal governments and local residents in case an earthquake disaster and a nuclear accident occurred at the same time. The prefecture requested that mechanisms be set up to promptly instruct local residents to evacuate and to publish the status of reactors after an earthquake in case a nuclear power plant was affected.

In response to this request, NISA outsourced research on complex disasters to a private company to create a viable nuclear emergency response manual applicable for complex disasters. Based on the research results, NISA drafted "Issues Requiring Attention When Preparing an Emergency Response Manual for Nuclear Emergency in Preparation for an Event Whereby a Large-Scale Natural Disaster Occurs Simultaneously or in line with Nuclear and Other Disasters (draft)" as of

April 27, 2009, submitting it to the Nuclear Emergency Preparedness Subcommittee of the Nuclear and Industrial Safety Subcommittee under the Advisory Committee on Natural Resources and Energy.

The draft incorporated some recommendations based on the outsourced research, but its disinclination to drastically change the existing disaster preparedness structure can be observed in this comment: "It is reasonable for us to implement effective and efficient measures against complex disasters in line with the current nuclear emergency preparedness structure, since complex disasters are highly unlikely to occur."

Specifically, the draft designated the Joint Council for Nuclear Emergency Response to discuss evacuation orders, which would not make the decision in a timely enough fashion. It also limited information disclosure activities to press releases provided by an Off-site Center, and did not design any special mechanisms for them. As such, the request from Niigata Prefecture was not reflected in the draft.

As the title of the draft, "Event Whereby a Large-Scale Natural Disaster Occurs Simultaneously or in line with Nuclear and Other Disasters," shows, NISA anticipated only the chance of a nuclear disaster occurring at the same time as a natural disaster, and did not focus on the possibility of a nuclear disaster that was triggered by a largescale natural disaster. This stance was based on NISA's past explanation to local governments hosting nuclear power plants that nuclear power plants were designed with extremely stringent safety examinations in mind. Assuming that a large-scale natural disaster could trigger a nuclear disaster would go against that explanation.

c. Objections posed by agencies of the national government and by some local governments hosting nuclear power plants

Between 2009 and 2010, NISA presented the draft to agencies of the national government and local governments hosting nuclear power plants, requesting their comments. Some national government agencies and local governments harshly objected to the content, with the result that there was no discussion of any measures for use in response to complex disasters.

The draft assumed a situation in which a nuclear disaster and a natural disaster might occur simultaneously. The organizations offering their comments claimed that this assumption would drastically impact their Regional Disaster Prevention Plans and incur large costs, and that the modified assumption itself was too onesided.

Some organizations also claimed that they were confused, since there was no clear image of the damage that was assumed in relation to complex disasters; they did not know the extent to which they needed to enhance their existing nuclear disaster prevention structure.

In particular, some local governments voiced visceral objections, with one organization claiming, "Simply assuming that a natural disaster and a nuclear disaster can simultaneously occur, publicly announcing measures in relation to this scenario, and instructing local governments in line with this assumption, would simply ruin all the efforts made by local governments." Some local governments also mentioned that the Central Disaster Prevention Council managed by the Cabinet Office should have convened to announce the content of the draft before it was reflected in their Regional Disaster Prevention Plan. This was based on the awareness among people involved in disaster prevention that the Central Disaster Prevention Council defining the Basic Plan for Emergency Preparedness as the basis for their Regional Disaster Prevention Plan had strong influence over the nuclear emergency preparedness structure of local governments. It became clear that the Act on Special Measures Concerning Nuclear Emergency Preparedness, stipulated shortly after the JCO Accident, did not necessarily define Japan's nuclear disaster prevention framework in a systematic manner and NISA, overseeing the Nuclear Emergency Preparedness Act, did not have enough power to single-handedly persuade the governments of localities hosting nuclear power plants.

d. No solutions provided by NISA

NISA did not offer any persuasive response to these opinions, and the discussion of this issue totally stagnated. Since no solutions were provided by NISA, no progress was made in implementing measures against complex disasters.

NISA revised the draft from scratch in the Nuclear Emergency Preparedness Subcommittee

Meeting held on October 14, 2010, more than one year after it had published the draft, specifying that (i) NISA would consult with the Cabinet Office to discuss a future implementation plan with the Central Disaster Prevention Council and that (ii) further assistance should be provided to local governments to compensate for their insufficient resources in dealing with complex disasters.

However, it was more than four months after the above Nuclear Emergency Preparedness Subcommittee, on February 28, 2011, before a specific discussion was held on (ii) assisting local governments. Also, it wasn't until March 8, 2011 that NISA consulted with the Cabinet Office concerning (i) the future implementation plan. In response to the approach from NISA, the managers of the Cabinet Office answered that the matter should be handled by NISA, since complex disasters were related to nuclear issues and could not be worked on by the Central Disaster Prevention Council.

The national government and municipal governments, by sticking to the existing nuclear disaster prevention framework and their traditional means of planning for disaster preparedness, hampered quick revision of the draft, leaving insufficient measures in place to provide for the safety of local residents.

e. The impact on this accident

No specific planning was done concerning complex disasters, so that only a few municipal governments explicitly described measures against complex disasters in their Regional Disaster Prevention Plan.

The Nuclear Emergency Response section in the Fukushima Prefecture Disaster Prevention Plan did not specify measures against complex disasters. As a result, the national government and the local government lacked consistency and coherence when implementing measures such as the evacuation of local residents, triggering multiple problems and confusion over many issues. This situation has already been described in 3.5.

2. Insufficient anticipation of complex disasters in nuclear emergency preparedness drills

a. Overview of nuclear emergency preparedness drills

Nuclear emergency preparedness drills in Japan include the comprehensive nuclear emergency preparedness drills conducted by the national government, and also the nuclear emergency preparedness drills periodically conducted by the municipal governments hosting nuclear power plants and other neighboring local governments based on their Regional Disaster Prevention Plan. Many prefectural governments conduct nuclear emergency preparedness drills on an annual basis. The national government has never provided programs targeting complex disasters in its comprehensive nuclear emergency preparedness drills. Some local governments, however, started initiatives against complex disasters.

b. Negative comments provided by NISA on nuclear emergency preparedness drills

On May 13, 2010, a meeting involving nuclear emergency preparedness organizations within Niigata Prefecture was held in order to plan nuclear emergency preparedness drills in the prefecture. The prefectural government took this opportunity to propose a scenario for drills where it was assumed an earthquake and a nuclear disaster occurred simultaneously, leading to some discussion.

On May 19, 2010, Niigata Prefecture consulted with NISA about planning nuclear emergency preparedness drills that included complex disasters. Niigata Prefecture suggested the following scenario: "The Chuetsu region is hit by a strong earthquake. Some nuclear power plant facilities are damaged by it, but no anomalies are observed at the nuclear reactors and no radioactive substances are released from the nuclear facilities. No serious damage is inflicted to evacuation routes and shelters, which are only partially damaged. Thereafter, various protection measures, including the evacuation of local residents, are required, since the nuclear reactor facilities experience problems unrelated to the earthquake and are expected to release large volumes of radioactive substances into the peripheral environment." This scenario assumed the simultaneous occurrence of a nuclear disaster and an earthquake, with no direct cause-and-effect relationship between them. NISA responded to the proposed scenario, commenting that the national government could not support the drills, since the scenario suggested that even limited damage to evacuation routes and facilities by

an earthquake could result in problems at a nuclear reactor, and drills conducted based on this ambiguous scenario could worry local residents unnecessarily.

Niigata Prefecture believed that a nuclear emergency preparedness drill to prepare against the simultaneous occurrence of earthquake and nuclear disasters would not mislead or concern their local residents. With no compromise made with NISA and the possibility of the cancellation of its emergency preparedness drill on the horizon, however, the prefecture thought it was best for them to conduct a drill regardless, as it was supposed to be conducted for the first time in five years. The prefecture held discussions with Kashiwazaki City and Kariwa Village, both of which host nuclear power plants, and explained at a nuclear emergency preparedness stakeholder meeting held on July 13, 2010 that the prefecture had decided to assume a snow disaster, in consideration of a heavy snowfall in the previous winter, as the scenario for the drill to be held that year; that would verify its emergency preparedness against complex disasters and minimize the confusion and concerns of local residents. The related organizations agreed to this decision, and the 2010 nuclear emergency preparedness drill for Niigata Prefecture was conducted on November 5, 2010.

NISA cited the following reasons why it was reluctant to conduct a nuclear emergency preparedness drill based on the assumption that a large-scale natural disaster could trigger a nuclear disaster: (i) severe nuclear accidents could never occur in principle, since extremely stringent safety examinations were conducted during the design phase of nuclear power plant construction, (ii) a fire that occurred at the Kashiwazaki-Kariwa Nuclear Power Plant in the wake of the Niigata-ken Chuetsu-oki Earthquake in 2007 was treated as something different from a nuclear disaster, and the safety features of the plant were fully functional, and (iii) local residents should not be misled or confused.

On the other hand, Ibaraki Prefecture based the implementation of nuclear emergency preparedness drills participated in by local residents on its Regional Disaster Prevention Plan; it conducted a comprehensive nuclear emergency preparedness drill with the participation of local residents on September 30, 2008, based on the assumption that an earthquake and a nuclear disaster might occur at the same time. As exemplified by these drills, some municipal governments started to implement nuclear emergency preparedness drills in anticipation of complex disasters. However, NISA never changed its stance that complex disasters were unlikely to occur at nuclear power plants, and it neither led nor conducted any emergency preparedness drills that responded to complex disasters.

3. Superficial implementation of the MIC recommendations against complex disasters

The Niigata-ken Chuetsu-oki Earthquake in 2007 made many recognize that important nuclear facilities–and the equipment important for emergency response at times of nuclear disaster–were not resilient enough to fully withstand an earthquake. The Ministry of Internal Affairs and Communications (MIC) published "Recommendations based on the administrative verification and monitoring results of nuclear emergency preparedness operations (#1)" (MIC recommendations) between 2007 and 2008, presenting various recommendations for addressing a complex disaster involving a largescale earthquake and a nuclear disaster.

Specifically, the "Earthquake-resistant measures implemented at important nuclear power plant facilities required to offer emergency disaster response," ("the recommendations on earthquake-resistant measures at important nuclear facilities") included in the MIC recommendations, prompted the Ministry of Economy, Trade and Industry (METI) to designate what nuclear operators were required to work on in order to make their critical facilities and equipment earthquake-resistant, including the setup of an emergency response office and communication facilities to disseminate information externally in the event of an emergency. METI was also asked to track and disclose the progress status of the efforts made by each nuclear operator.

NISA made each nuclear operator submit an "action plan concerning self-sufficient fire-extinguishing and information delivery," in line with the recommendations on earthquake-resistant measures at important nuclear facilities, on the earthquakeresistant measures implemented at the operator's central processing facility. The action plan submitted by each operator to METI included an item entitled "Enhanced earthquake resistance by anchoring the processing equipment of monitoring post data." As of September 30, 2008, NISA was notified that

all the nuclear power plants, including the Fukushima Daiichi Nuclear Power Plant, had completed their action plan.

However, the outage of all alternating-current power sources triggered by the earthquake and tsunami on March 11, 2011 disabled all monitoring posts placed on the premises of the Fukushima Daiichi Nuclear Power Plant.

This situation suggests that the operators had only been taking superficial measures against complex disasters based on the recommendations on earthquake-resistant measures at important nuclear facilities, and that NISA had not done enough to confirm their implementation. By not enhancing the necessary facilities through careful consideration of the possibility of complex disasters, both the operators and NISA made it impossible to accurately monitor the leakage of radiation from the Fukushima Daiichi plant, and this led to the inadequate protection of local residents.

[National Diet Report] Chapter 4, 4.3.2

4.3.3 Superficial comprehensive nuclear emergency preparedness drills conducted by the national government

The comprehensive nuclear emergency preparedness drill conducted annually by the national government did not anticipate severe accidents or complex disasters at all. It was virtually useless as a measure to increase preparedness for nuclear accidents.

1. Overview of the comprehensive nuclear emergency preparedness drill conducted by the national government

The nuclear emergency preparedness drills conducted in Japan include the comprehensive nuclear emergency preparedness drill conducted by the national government, and also the nuclear emergency preparedness drill conducted by municipal governments hosting nuclear power plants and other neighboring local governments. The comprehensive nuclear emergency preparedness drill conducted every year under the leadership of the national government, stipulated by Article 13 of the Act on Special Measures Concerning Nuclear Emergency Preparedness, had virtually lost its usefulness, because no substantial changes had been made over the years regarding accident severity assumptions, prior preparations for the drill and the measures to be implemented.

2. Superficial implementation of the nuclear emergency preparedness drill by the national government

a. Insufficient assumptions of the probability of severe accidents

The comprehensive nuclear emergency preparedness drill assumed the events defined by Article 15 of the Act on Special Measures Concerning Nuclear Emergency Preparedness. However, it did not anticipate critical events on the scale of this accident.

For example, the comprehensive nuclear emergency preparedness drill held in 2008 assumed a nuclear core damaged by the failure in the cooling functions, which was triggered by multiple equipment failures of the emergency nuclear core cooling system. It further assumed an event defined by Article 10 of the Act on Special Measures Concerning Nuclear Emergency Preparedness three hours after the occurrence of the accident, and another event defined by Article 15 of the Act on Special Measures Concerning Nuclear Emergency Preparedness seven hours after that (i.e. 10 hours after the occurrence of the accident). The scenario was based on a slow progression of these successive events.

We suppose that one of the reasons NISA did not consider the probability of severe accidents in conducting drills was that it might have proven unacceptable to the local governments participating in the drills.

b. Insufficient anticipation of complex disasters

When conducting the comprehensive nuclear emergency preparedness drill, NISA assumed that complex disasters were highly unlikely to occur, and did not consider the possibility of anomalies occurring simultaneously with a nuclear accident. The organization did not assume any of the

numerous challenges that might occur at the time of a complex disaster, such as difficulties dispatching personnel from Tokyo to the Off-site Center, or communication problems between the Nuclear Emergency Response Headquarters (NERHQ) and the Local Nuclear Emergency Response Headquarters (Local NERHQ). The comprehensive nuclear emergency preparedness drill conducted in 2008, for example, assumed that the personnel dispatched to the Local NERHQ would start their travel after the occurrence of an event defined by Article 10 of the Act on Special Measures Concerning Nuclear Emergency Preparedness and reach the local site within two hours. In reality, the latest nuclear accident required more time to dispatch personnel, including the director-general of the Local NERHQ, to the Off-site Center.

c. Superficial implementation of drills due to their expansion of scale

The comprehensive nuclear emergency preparedness drill is a large-scale drill involving many stakeholders, including the prime minister and the minister of Economy, Trade and Industry, who oversee the entire government organization in the event of a disaster. A huge amount of work is required in preparation for this drill, with many meetings that last several hours. The Nuclear Emergency Preparedness Division of NISA, which is in charge of the annual comprehensive nuclear emergency preparedness drill, spends about a year preparing for this drill, starting with the planning phase.

The preparations for the comprehensive nuclear emergency preparedness drill in 2008 took approximately nine months. These included: a total of six meetings to coordinate activities among the central government, local governments, and nuclear operators: two meetings with aviation and other personnel; and five briefings conducted by Fukushima Prefecture for local organizations.

Participants in the comprehensive nuclear emergency preparedness drill change every year due to personnel transfers and changes of administration in the central government. The various organizations in charge of the drill are required to brief participants from scratch every time the drill is conducted. The time available to brief participants from the central government, including bureaucrats and politicians, is very limited. With the huge amount of time required for preparation, in practice the drill was only conducted in line with a predetermined scenario. It was far from viable or effective.

3. The impact on this accident

Emergency preparedness drills do not merely allow participants to actually experience evacuation or obtain related knowledge. Repeating effective drills is critical in enabling participants to discover new practical concerns, and improve their preparedness for unexpected events and emergency situations.

However, the comprehensive nuclear emergency preparedness drill conducted by the national government was aimed primarily at not worrying or confusing local residents, and also at respecting the concerns of local governments that hosted nuclear power plants. In a sense, the drill was conducted for the sake of having a drill. It was superficial in nature; just the fact that the drill was actually held was considered important. Naturally, it lacked effectiveness in response to actual accidents. This type of impractical drill did not enable participants to obtain a deeper understanding of the various systems in place for nuclear disasters, including SPEEDI. A NAIIC survey of local residents (see Fig. 4.3.3-1) shows that the ratio of local residents who actually participated in evacuation drills conducted by the national government or municipal governments was only around 10 to 15 percent, even in the local communities that host nuclear power plants. Virtually no local government officials or local residents claimed that past emergency preparedness drills helped them weather this accident.

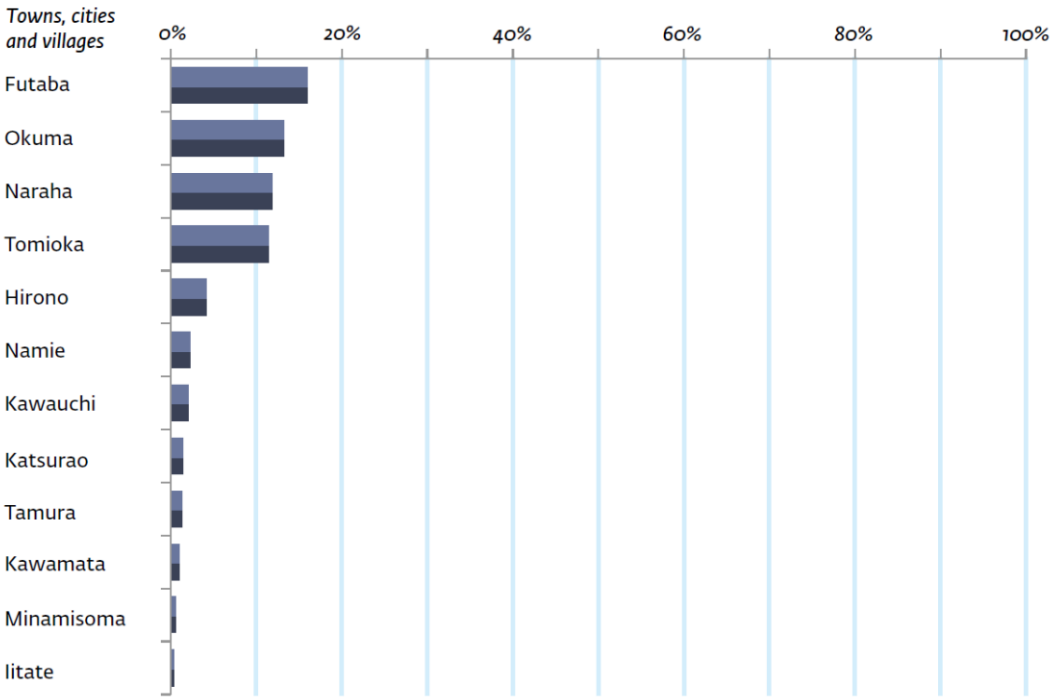


Fig. 4.3.3-1: Ratio of local residents receiving evacuation drills before the accident (against all evacuated residents)

[National Diet Report] Chapter 4, 4.3.3

Section 5 "Preparedness" for complex nuclear disaster and Fukushima Daiichi accident

In the "Guideline for Measures for Nuclear Installations" (that is "Nuclear Emergency Guideline"), which was prepared by the NSC, there is no description about measures in the case of a complex disaster (natural disaster, armed attack and nuclear accident). It is obvious that the Fukushima Daiichi accident is a complex disaster (earthquake, tsunami and nuclear accident). The situation in which the relevant organization cannot avoid blindly responding without "preparedness" led to confusion in evacuation order. The Act on Special Measures Concerning Nuclear Emergency Preparedness and the Nuclear Emergency Guideline, forming the current nuclear emergency system, was made on the basis of experiences mainly in the JCO criticality accident (1999). Before the criticality accident, it was prescribed that in the case of the occurrence of an accident, the Emergency Response Support System (ERSS) would be established in the Agency of Natural Resources and Energy, which was a primary regulatory agency in those days and experts in the Nuclear Safety Commission (NSC) would respond there. However, in the case of the JCO criticality accident, Dr. Kenji Sumita, NSC Deputy Chairman conducted a study of controlling the accident at the Tokai site, which led to good estimation. In the "Investigation Committee for Uranium Processing Plant Criticality Accident Report" published by the NSC, there is a description that a prototype "off-site center plan", which was recommended by the technical committee of the neighboring disaster prevention measures such as nuclear power plants 5 months before the JCO accident, has been put into practice, which has significant meaning.

On the basis of a kind of "experience in success" after the JCO accident, it was incorporated in the Nuclear Emergency Guideline that an off-site center should be established around each nuclear power plant. In other words, this is a concept of system design to set a central function for emergency measures in field headquarters near the site collecting relevant staff. Such an emergency preparedness system is considered to be effective to some degree in the case that the field headquarters is capable of functioning sufficiently because progress of an event is not so rapid.

However, in the case of the occurrence of a nuclear disaster due to external events such as

earthquake and tsunami, there is high possibility that the disaster due to each event simultaneously occurs and responses to the disaster in the fieldheadquarters is expected to be difficult. Actually, in the responses to the present accident in Fukushima Daiichi NPS, the system to conduct the emergency activities under the field headquarters did not function, since relevant staff could not be gatahered owing to the catastrophic damage to infrastructure caused by the earthquake and tsunami, and continuous information exchange was difficult because of quite vulnerable means of communication owing to a large-scale blackout and the ambient radiation level in the off-site center increased according to the progress of the events of the accident.

It was not always the case that staff associated with safety regulation did not consider about the possibility of complex disaster at all. For example, in the trusted research in FY 2008, JNES (an organization supporting regulatory agency) investigated responses in complex disaster of nuclear power plants in United States. In addition, NISA requested relevant organizations to consider the possibilities of failings in the function of the off-site center and emergency radiation monitoring, in spite of the following statement, "There is a low probability to actually cause a complex disaster" in a document "Points to be considered in making a manual for nuclear emergency preparedness (draft)" in April 2009. However, from the current viewpoint after the experiences in the Fukushima nuclear accident, criticism against too easy understanding of importance of measures could not be avoided because measures had not been promptly implemented owing to too low estimated possiibility of the occurrence of a complex disaster.

[Nongovernmental Report] Part 3 Chapter 7 Section 5

The following isssues can be raised in association with opportunity of revision of nuclear emergency preparedness for complex disaster.

Nuclear emergency preparedness system – opportunity of revision of nuclear emergency preparedness for complex disasters (earthquake, tsunami, and nuclear accident)

- Although problems of emergency preparedness assuming the possible occurrence of a nuclear emergency coupled with a complex disaster were pointed out, no measures were taken against them.
  - Upon requests from the Niigata prefectural government, following the occurrence of a fire at the Kashiwazaki-Kariwa NPS when it was struck by the Niigata-ken Chuetsu-oki Earthquake, the national government requested the investigation committee on the accident at the Kashiwazaki-Kariwa NPS to examine and report on the issue of preparedness against a nuclear emergency coupled with a complex disaster. The report produced by the investigation committee stated the government's intention to resolve the issues that require attention when responding to a nuclear emergency in a complex disaster under the leadership of NISA.
  - However, the draft document entitled "A Draft on the Issues Requiring Attention When Preparing an Emergency Response Manual for Nuclear Emergency Coupled with Complex Disaster" submitted by NISA in April 2009, stated that the probability of a nuclear emergency being coupled with a complex disaster was extremely small, on the basis of the view that nuclear power facilities employ a seismic structural design and are technologically well protected against earthquakes on a design basis level, as well as the view that the incident that had taken place at the Kashiwazaki-Kariwa NPS as a result of the

Niigata-ken Chuetsu-oki Earthquake fell short of being a nuclear emergency. Therefore, the draft document concluded that it was reasonable to develop countermeasures on the basis of ongoing organizational arrangements for disaster prevention and negated the need to make new organizational arrangements for disaster prevention assuming the possible occurrence of a nuclear emergency coupled with a complex disaster.

- The draft document received the following criticisms, which argued against the very act of developing countermeasures against a nuclear accident coupled with a complex disaster, from concerned agencies of the national government and local governmental organizations:

  (i) The development of countermeasures against a nuclear emergency in a complex disaster may become a cause of the mistaken view that major natural disasters are likely to initiate a nuclear emergency;

  (ii) The implementation of countermeasures against a nuclear emergency in a complex disaster will require major modifications to regional disaster prevention plans, etc.; or

  (iii) There has not been sufficient negotiation with concerned organizations for affairs to be handled by an organization other than NISA.

- In response to such criticisms, NISA revised the draft from scratch in October 2010, specifying that (i) NISA would consult with the Cabinet Office to discuss a future implementation plan with the Central Disaster Prevention Council and that (ii) further assistance should be provided to local governments to compensate their insufficient resources in dealing with complex disasters. A specific discussion on (ii) was held as late as 28 February 2011. Also, it was not until 8 March 2011 that NISA consulted with the Cabinet Office concerning (i). In response to this approach from NISA, the managers of the Cabinet Office answered that the matter should be handled by NISA, since complex disasters were related to nuclear issues and could not be worked on by the Central Disaster Prevention Council.

- The national government and municipal governments, by sticking to the existing nuclear disaster prevention framework and their traditional means of planning for disaster preparedness, hampered quick revision of the draft, leaving in place measures that were insufficient to provide for the safety of local residents.

- It had been pointed out, as a result of the administrative evaluation/monitoring by the Ministry of Internal Affairs and Communications (MIC) in February 2009, that measures would be needed to reduce exposure to doses of radiation within the Off-site Center in the event of a nuclear accident. Nonetheless, NISA failed to take adequate measures.

2.2 Issues raised in the first JHPS recommendations

In the first JHPS recommendations entitled "Issues Associated with Radiation Protection after Fukushima Daiichi Nuclear Power Plant Disaster - Responses of and Recommendations from Japan Health Physics Society -" released on 17 April 2012, important issues associated with radiation protection were summarized into the following eleven items in accordance with the exposure situation that changed over time after the accident, on the basis of discussions during the symposia on Measures for Dealing with the Fukushima Nuclear Disaster and a session on the Fukushima Daiichi nuclear disaster at the 44th JHPS Annual Meeting in 2011.

1) Comprehensive issues related to all situations
   (Issue 1) Strategies for reducing anxiety and doubts of the general public regarding radiation risk
   (Issue 2) Methods of measuring ambient dose rate, surface contamination density, and concentration of radioactive materials in foods
2) Issues related to emergency exposure situation
   (Issue 3) Criteria for evacuation and stay in house
   (Issue 4) Administration of stable iodide
   (Issue 5) Principles for regulation of ingestion of foods and drinks
   (Issue 6) Screening criteria for decontamination
   (Issue 7) Dose limit for emergency workers
   (Issue 8) Post disaster investigation of thyroid equivalent dose of radioactive iodine
3) Issues related to existing exposure situation
   (Issue 9) Provisional criteria for judging the safety of using school yards, forage, cropping soil, fertilizers, bathing areas, etc.
   (Issue 10) Systems for temporary entry into restricted zones
   (Issue 11) Management of radioactive wastes such as cesium-containing rubble, sludge, and decontaminated soil

The points of discussion mentioned above are described below.

<u>Issue 1: Strategies for reducing anxiety and doubts of the general public regarding radiation risk</u>

[Points of discussion]

- Anxiety of the general public regarding foods and drinks
  Foods and drinks are daily necessities. The general public is worried about their radiation risks in the case of daily shopping and needs information on whether people should purchase them. It is important to understand the correct meaning of regulatory values of foods and drinks and to verify how the actual radiation measurements of foods and drinks are carried out and whether measurement results are disseminated to consumers with accuracy.
- Anxiety of the general public regarding contamination hot spots
  There are many cases wherein high-level radioactivity is found in sewage sludge and incinerated ash in the Kanto district, and radioactivity relatively higher than that in areas surrounding residential communities is observed, whereas the amount of

radiation exposure would be minimal if it is estimated in terms of the radiation effect on the human body. It is important to respond to the needs of local residents and properly inform them of the results of dose assessments.

- Anxiety of the general public regarding provisional criteria for judging the safety of using school yards, forage, cropping soil, fertilizers, bathing areas, etc.

  Although parameters and exposure scenarios for deriving these criteria are assumed conservatively, it is important to comprehensively and correctly disseminate the methods of deriving the criteria and their magnitude of conservativeness.
- Anxiety of the general public regarding pregnant women, fetuses, and children

  The radiation sensitivities and risks of pregnant women, fetuses and children are higher than those of adults. This high sensitivity is not considered in the current domestic radiation protection system that is based on international standards, except for the regulation for the thyroid equivalent dose for infants in an emergency exposure situation. A simple explanation on the triviality of radiation exposure leads to the shortage of information. A well-balanced radiation protection system must be reconstructed, taking into consideration the relatively high sensitivity of younger individuals and comprehensive accountability to the general public.

Issue 2: Methods of measuring ambient dose rate, surface contamination density, and concentration of radioactive materials in foods

[Points of discussion]

- Methods of measuring ambient dose rate

  Some ambient dose rate meters in local governments are set on the housetops because the measurement target is radioactive plume in the air. It is necessary to take into consideration the measurement height dependence in the case of radiation monitoring on broadly contaminated soil. The method of measuring the ambient dose rate according to the monitoring objective must be standardized, that is, to select a short time constant in the case of an overall survey of contamination hot spots.
- Consideration of high background count rate

  In many cases, Geiger-Müller (GM) survey meters for surface contamination are usually used in measurements of surface contamination density for beta emitters. Since this type of survey meter has a low sensitivity for gamma rays that come from outside of the surface of a detection area, the net count rate should be estimated in the case of measuring the surface contamination density by subtracting the background count rate that increases with the ambient dose rate from the measured total count rate. Such a method must be standardized.
- Methods of measuring the concentration of radioactive materials in foods

  A highly accurate Ge semiconductor detector is often used to confirm that radioactivity concentration in foods is below the regulatory values, on the other hand, the measurement system is too expensive. Outsourcing to measure them is also expensive. For this reason, screening measurement using a NaI(Tl) scintillation survey meter that is relatively cheaper to purchase may be feasible. In the case of such a simple screening measurement, a gamma ray shield is necessary to reduce the background count rate accordingly. An appropriate measurement method must be standardized, taking into consideration the relationship between the detection limit

and regulatory values in foods.

- Methods of estimating internal dose using whole-body counters and the bioassay method

  Estimation of internal exposure using whole-body counters and the bioassay method depends on how to calibrate the measurement system in accordance with radioactive nuclides and how to provide a dose coefficient assuming a variety of timings of intake, which is a significant issue that would clearly affect the effective dose assessment. Considering such issues, the method of estimating the internal exposure must be standardized.

- Methods of measuring a screening level for the thyroid equivalent dose of radioactive iodine

  A screening level for simplified thyroid measurement that is equivalent to 100 mSv thyroid equivalent dose for one-year-old infants was established just after the Fukushima accident. In the case of such a simplified measurement, it is necessary to maintain a constant distance between the survey meter and thyroid of the target person, and to subtract the background ambient dose rate from the measured dose rate. Considering such issues, the method of measuring a screening level for the thyroid equivalent dose of radioactive iodine must be standardized.

Issue 3: Criteria for evacuation and stay in house

[Points of discussion]

- Balance among other emergency criteria (the same as Issues 4 and 5)

  In the current system, the emergency criteria of evacuation and stay in house, distribution of stable iodide, and regulation of the ingestion of foods and drinks are independently determined. The emergency measures are closely connected, that is, it is stated that stable iodide should be distributed at evacuation centers after the evacuation instruction. It is important to determine the emergency criteria by overlooking beyond each emergency criterion.

- Assumption of long-term emergency situation and maintenance of infrastructure including electricity, water, and communications (the same as Issue 5)

  The current system assumes a short-term and temporary emergency situation. Emergency measures applicable to a long-term emergency situation must be examined by considering the balance with the maintenance of infrastructure including electricity, water, and communications.

- Use of SPEEDI and simulations on the diffusion of radioactive materials in the ocean

  The results of the System for Prediction of Environmental Emergency Dose Information (SPEEDI) and simulations on the diffusion of radioactive materials in the ocean must be disclosed at an early stage so that municipalities and evacuees can actively use the data.

- Communication with residents to designate the deliberate evacuation zones

  Since residents in the deliberate evacuation zones have sufficient time to evacuate, the designation of deliberate evacuation zones and the deadline for the completion of evacuation must be determined after sufficient discussions with municipalities.

- Emergency planning zones (EPZs) (the same as Issue 4)

  Emergency planning zones (EPZs) that are designated for emergency preparedness

within a radius of 8-10 km from nuclear power plants and related anti-disaster measures through full discussions with municipalities must be reviewed by considering the post disaster spread of contamination to a large area.

Issue 4: Administration of stable iodide

[Points of discussion]

- Balance among other emergency criteria (the same as Issues 3 and 5)

  In the current system, the emergency criteria of evacuation and stay in house, the distribution of stable iodide, and regulation of the ingestion of foods and drinks are independently determined. The emergency measures are closely connected, that is, it is stated that stable iodide should be distributed at evacuation centers after the evacuation instruction. It is important to determine the emergency criteria by overlooking beyond each emergency criterion.
- Emergency planning zones (EPZs) (the same as Issue 3)

  Emergency planning zones (EPZs) that are designated for emergency preparedness within a radius of 8-10 km from nuclear power plants and related anti-disaster measures through full discussions with municipalities must be reviewed by considering the post disaster spread of contamination to a large area.

Issue 5: Principles for regulation of ingestion of foods and drinks

[Points of discussion]

- Balance among other emergency criteria (the same as Issues 3 and 4)

  In the current system, the emergency criteria of evacuation and stay in house, distribution of stable iodide, and regulation of the ingestion of foods and drinks are independently determined. Since the emergency measures are closely connected, it is important to determine the dose criteria for the derivation of provisional regulatory values for radioactive materials contained in foods by overlooking beyond each emergency criterion.
- Assumption of emergency situation over a long-term and maintenance of infrastructure including electricity, water, and communications (the same as Issue 3)

  The current system assumes a short-term and temporary emergency situation. Emergency measures applicable to a long-term emergency situation must be examined by considering the balance with the maintenance of infrastructure including electricity, water, and communications.
- Category of foods

  In the provisional regulatory values (by 31 March 2012) for radioactive materials contained in foods before the disaster, the restriction value for radioactive iodine in fish, for example, was not specified. The categories of foods must be reviewed, taking into consideration the annual amounts of ingestion and monitoring results of actual foods.
- Scope of radioactive nuclides except for key nuclides

  Provisional regulatory values (by 31 March 2012) for radioactive materials contained in foods were derived assuming the ratio, Cs-137:Sr-90 = 1:0.1. Since radioactive strontium tends to concentrate in bone in the food chain, the provisional regulatory values must be reviewed by considering the results of radiation monitoring in marine

products.

Issue 6: Screening criteria for decontamination

[Points of discussion]

- Validity of screening levels (100 and 13 kcpm) from the viewpoint of radiation protection

  The local nuclear emergency response headquarters increased the level of screening contaminated surfaces for decontamination to 100 kcpm (100,000 counts per minute) on 20 March 2011 following the advice from the Nuclear Safety Commission of Japan. The screening level was equal to the criterion for decontamination in the International Atomic Energy Agency (IAEA) publication entitled "Manual for First Responders to a Radiological Emergency", which is equivalent to 1 μSv/h at a distance of 10cm. It was then lowered to 13 kcpm on 16 September 2011 following the advice from the Commission that it is desirable to appropriately decrease the screening level in a stepwise manner by considering the overall situation such as radiation monitoring results and number of people going in and out of the checkpoint. The validity of the screening criteria for decontamination in an emergency must be verified in terms of their effectiveness for radiation protection by considering the relationship between screening levels for radioactive nuclides and effective doses owing to surface contamination remained without decontamination in accordance with the principles of other emergency measures.

- Underestimation of count rate of GM survey meters

  In many cases, Geiger-Müller (GM) survey meters have been used to measure the radioactive contamination of surfaces. GM counters underestimate the actual count by at least 20% in the measurement range with a count rate of as high as 100 kcpm because of the occurrence of dead time due to a long resolving time. Such an issue in radiation measurement must be included in the verification of the validity of the criteria from the viewpoint of radiation protection.

Issue 7: Dose limit for emergency workers

[Points of discussion]

- Transition of dose limit for emergency workers to 250 mSv

  In the second interim report on the incorporation of the 2007 Recommendations of the International Commission on Radiological Protection (ICRP) into domestic systems, the Basic Committee of the Radiation Council proposed to match the dose limits to internationally recommended values because the current restriction criteria in Japan (dose limit, 100 mSv) interfered with emergency medical care and other essential operations. On the other hand, the Ministry of Economy, Trade and Industry on 16 March 2011 consulted the Radiation Council to change the upper limit of individual dose for emergency workers from 100 to 250 mSv and obtained an opinion that such a revision was appropriate on 26 March 2011. Taking into consideration that the other various emergency measures are based on internationally approved principles and the recommended value of the 2007 Recommendations of ICRP (emergency medical care, no restriction; other emergency rescue operations, 1,000 or 500 mSv; other rescue operations, 100 mSv), 500 mSv must be adopted as a

dose limit for emergency workers.

- Relationship between individual dose received in an emergency situation and dose limit for radiation workers under normal conditions

  When the individual dose received in emergency situation is applied to control the exposure of radiation workers under normal conditions (50 mSv per year and 100 mSv over five years), radiation workers who have been exposed to radiation exceeding 100 mSv during emergency work are prevented from engaging in radiation work for a given period. After this disaster, taking into consideration that the dose limit for emergency workers was set to 250 mSv, which is lower than the internationally recommended value, and the current dose limit under normal conditions for radiation workers was determined on the basis of a lifetime individual dose of 1,000 mSv, the individual dose in an emergency should be controlled independently of a compliance of the dose limits for radiation workers under normal conditions (50 mSv per year and 100 mSv over five years) to control radiation exposure.

Issue 8: Post disaster investigation of thyroid equivalent dose of radioactive iodine

[Points of discussion]

- Simulating the atmospheric diffusion of the radioactive plume using SPEEDI and surveys on residents' behavior

  Radiation monitoring was not satisfactorily carried out for approximately one week after the nuclear disaster owing to its aftermath. Therefore, the results of simulations of the atmospheric diffusion of the radioactive plume using SPEEDI and surveys on resident's behavior are essential for assessing the thyroid equivalent dose for radioactive iodine among residents after the disaster. The thyroid equivalent dose for radioactive iodine must be estimated and disclosed with its uncertainty on the basis of the results of simulating the atmospheric diffusion of radioactive plume using SPEEDI and surveys on residents' behavior.

Issue 9: Provisional criteria for judging the safety of using school yards, forage, cropping soil, fertilizers, bathing areas, etc.

[Points of discussion]

- Balance among provisional criteria

  As a temporary policy for judging the safety of using school yards and other outdoor facilities, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) initially announced a provisional criterion of 3.8 μSv/h, which was derived from the reference level of 20 mSv/y, and decided to aim to reduce the level of contamination to 1 mSv/y. The provisional criteria for forage fed to cows, cropping soil, and fertilizers announced by the Ministry of Agriculture, Forestry and Fisheries (MAFF) were derived on the basis of the provisional values for foods, which was determined with consideration of the individual dose for radioactive cesium (5 mSv/y). In addition, the provisional criterion for bathing areas announced by the Ministry of the Environment (MOE) was derived so that the individual dose due to external and internal exposure was within 10% of 1 mSv/y. These provisional criteria must be reconsidered on the basis of the overall policy by considering the radiation

sensitivity of children and the balance among reference levels including and, if necessary, adopting stepwise reference levels.

Issue 10: Systems for temporary entry into restricted zones

[Points of discussion]

- Balance among radiation protection measures, inconvenience and heat stroke

  During the temporary home visits allowed in summer 2011, the room temperature reached 37 ^{o}C at some centers established as relay points through which residents returned to their homes. Therefore, the requirement of wearing Tyvek clothing was loosened to prevent heat stroke, i.e., people wearing long-sleeved clothes and long trousers were allowed to enter the restricted zones, although they were required to wear overshoes, gloves, a mask, and a hat. The maximum time spent at home was limited to 2 h, and the total time taken for the round trip from the relay point to their homes was limited to 5 h. Since the elderly were included in the list of individuals allowed temporary home visits, flexible systems must be proposed by considering their own needs and ages, rather than uniformly imposing the wearing of a protective suit and limiting the entry time.

Issue 11: Management of radioactive wastes such as cesium-containing rubble, sludge, and decontaminated soil

[Points of discussion]

- Policy for managing radioactive wastes under the existing exposure situation

  The radiation protection policies for the disposal of radioactive wastes in ICRP and the Nuclear Safety Commission in Japan have been established assuming the situation is under normal condition (planned exposure situation) where the dose limit for the public of 1 mSv/y is complied. The application of these policies to the management of radioactive wastes (e.g., temporary placement, treatment, storage, and disposal) under the existing exposure situation, where decontamination (dose reduction) in a large contaminated area is planned by setting reference levels chosen from between 1 and 20 mSv/y, may be unrealistic from the viewpoints of justification and optimization taking into consideration social and economical factors. The radiation protection policy for the management of radioactive wastes under the existing exposure situation must be established to make the environmental restoration reasonably practical.

- Reference level for managing radioactive wastes

  In the existing exposure situation, the management of radioactive wastes is justified when the decrease in the ambient dose due to decontamination is judged to be appropriate despite the potential exposure to radiation due to the management of the radioactive wastes necessary for decontamination. Justification and optimization should be fully discussed in the overall plan of environmental restoration. Considering the reference level for the management of radioactive wastes is used to reduce the ambient dose in a large contaminated area, the reference level for the management of radioactive wastes must be selected below the reference level for the existing ambient dose in a stepwise manner. (When environmental restoration is carried out by lowering the reference level for ambient dose due to a broadly

contaminated land in a stepwise manner during the management of radioactive wastes, lowering the reference level for the management of radioactive wastes can be achieved by restricting the entry of the public or imposing additional shielding measures.)

- How to determine the reference level for managing radioactive wastes
  Stepwise approaches to decrease the individual dose should be taken by sharing the plan of environmental restoration, including the management of radioactive wastes, with stakeholders including local residents under the existing exposure situation. The optimized reference level for radioactive waste management in the existing exposure situation must be selected from the dose band (1 to 20 mSv/y) with the relevant stakeholder involvement.
- Dose criteria for disposal of radioactive waste
  When the temporary placement and storage are completed and the radioactive waste management enter the disposal stage, radioactive wastes must be disposed of in a planned manner so that the assessed individual dose becomes a target dose of 1 mSv/y or less, which corresponds to the individual dose under normal conditions, in line with the long-term goal of decreasing the individual dose due to environmental radiation to less than the order of 1 mSv/y.

2.3 Issues and recommendations raised at the JHPS symposia

(1) Special Symposium on the second Fukushima project (25 May 2013)

In this section, comments made at the JHPS symposium held on 25 May 2013 are listed. Voice records of speakers and audience members in the symposium are given in Appendix I. Important issues and recommendations associated with radiological protection were selected from recordings made at the symposium from the viewpoint of finding new points that had not yet been raised in the draft report at that time, and are summarized in simple terms.

(Monitoring for internal exposure)

- When using a great number of whole body counters (WBCs) as a monitoring tool, it is important to manage their accuracy and to ensure traceability of calibration from the viewpoint of maintaining the reliability of the measurements. As there are no standards for the WBCs, standardization should be carried out on the basis of recommendations of the expert research group in JHPS.
- Standarizations of the standard phantom for calibration, detection limit, analyzing method of the gamma spectrum, and the dose assessment are necessary. Also, a standard manual for operators of the WBCs is needed.
- It is necessary to consider the maintenance of a great number of WBCs including the training of monitoring staff.
- To explain the monitoring results of the WBCs to the public, it is also necessary to make a Q&A booklet to enhance their understanding and assemble a manual taking into consideration risk communication.
- Occupational exposure has been, so far, the target of WBC measurement. Moreover, internal exposure monitoring of the thyroid gland in terms of nuclear emergency preparedness was carried out, which was a main cause of delay of the WBC measurement.
- Priority of the order of the WBC measurement should be established a priori; for instance, children sensitive to radiation and families with children should have first priority, because the number of WBCs is limited.
- Another issue is how accuracy should be maintained for the public, including children with different body sizes.

(Environmental monitoring and its assessment)

- Following the Fukushima Dai-ichi nuclear power plant accident, it has become necessary to revise the initial environmental monitoring method, in particular, to construct an environmental monitoring system considering post-accident investigation of thyroid equivalent dose.
- Equipment and a system to inform the public of monitoring results of measurement are needed to utilize not only governmental but also nongovernmental powers.
- It is important to make a system incorporating the guidelines with better understanding of method and a framework to maintain the system for developing human resources in spite of a long time having passed, and to continue training staffs in the operation of the guidelines.

(Risk communication)

- "Risk communication to the public – to ensure human resources" was pointed out as issue 35 in this draft report, but a more important issue than ensuring the procurement of human resources is that we have neglected efforts to improve people's understanding of radiation.
- "Risk communication to the public – comprehensibility of the radiological protection system" was pointed out as issue 36 in this draft report, but it is necessary to make emergency preparedness guidelines available even in situations without electricity or communication infrastructures.
- "Risk communication to the public – utilization of mass media" was pointed out as issue 37 in this draft report, but communication through the internet has limitations. It is important to develop human resources for risk communication in the municipal government and to ensure that radiation effects can be explained in a face-to-face manner in an emergency.
- "Risk communication to the public – response to foreign residents and overseas countries" was pointed out as issue 38 in this draft report, but if information is spread, anxiety would be reduced. Foreigners surrounded by Japanese people with sufficient knowledge and information of the accident will feel less anxiety. First, it is important to raise the knowledge level of Japanese people regarding radiation.

(General discussion)

- We should remember that simulation results by the System for Prediction of Environmental Emergency Dose Information (SPEEDI) are merely predictions and not consistent with the actual results. It may be a problem to use SPEEDI in a judgment regarding the administration of stable iodine on the basis of information on whether or not the predicted level meets the thyroid equivalent dose criterion. SPEEDI should be utilized appropriately because it has an important role in emergency preparedness.
- Issues and recommendations should be selected considering the difference in risk communication between normal and emergency situations, since there are various considerations, for example, things to be done in a normal situation, things additionally needed in a transition from a normal to an emergency situation and things to be utilized as they are.

(2) Special Symposium II on the second Fukushima project (22 February 2014)

In this section, comments made at the JHPS symposium held on 22 February 2014 are listed. Voice records of speakers and audience members in the symposium are given in Appendix II. Important issues and recommendations associated with radiological protection were selected from recordings made at the symposium from the viewpoint of finding new points that had not yet been raised in the draft report at that time, and are summarized in simple terms.

(Dose criterion for rehabilitation)

- As given in recommendation 19, it is desirable to decide the dose criterion with the active cooperation and understanding of stakeholders. However, I've understood that this is fairly difficult after hearing a presentation in the morning session today. In the second set of recommendations, it is better to recommend the manner in which experts

should support society.

(Risk communication)

- I don't have the confidence to clearly explain the meaning of the criterion, but there must be examples of successful experiences in explaining the criterion to the public. It is effective to share the successful experiences among experts because such successful experiences were archived by the organization.
- In the morning session today, there was a report on the current status of contaminated water in the Fukushima Daiichi NPS. In the current draft of the recommendation, contaminated water was not mentioned, but I would like to add this point as an item of risk communication.

(Decision-making process)

- The process to determine the dose limitation in an emergency of 250mSv was not carried out in a transparent manner. I think that the process used to make various decisions should be clearly disclosed to the public. There were some cases in which the process was not clear, and the decision-making process was like a black box. Regarding this point, I would like to make a recommendation.
- In the release of water contaminated with low-level radioactive material to the ocean, I would like you to include the importance of transparency in the decision-making process and of public relations in this recommendation because the process was like a black box.

(Education on radiation)

- It is necessary to improve education on radiation and risk not only in the affected area but also in the entire country.
- Regarding education on radiation, risk communication in the current draft recommendation seems to be for residents close to the site, but there is little mention of education on radiation taking Japan as a whole into consideration. I would like you to add this point to take account of the follow-up after the recommendation.
- In the recommendation, the action of providing comprehensive information and knowledge should be included.
- Regarding stakeholder involvement, I think that the discussion has continued without any consideration of the benefits of radiation, despite there being both risks and benefits. As the discussion on risks and benefits has only focused on safety and danger, this should be included in the recommendation.
- Not only radiation but other applications of science are not only evaluated in terms of whether they are safe or dangerous, which should be a fundamental part of education. Otherwise, explanations by experts will not be understood by the public.

(Fundamental policy in the elaboration of recommendations)

- I was afraid that there is no subject in the recommendation, but I am delighted to hear the speaker's explanation of the reason including the speaker's intention to consider that people who read this recommendation will voluntarily act from their standpoint. I would like you to add such a reason to the recommendation.

2.4 Arrangement of issues

Including issues raised in the first JHPS recommendations and the JHPS symposium, the issues pointed out in the above sections are arranged in the following manner.

Radiation monitoring on land – unexpected effects on means of transportation and communication

Issue 1: Radiation monitoring on land could not proceed following the previously determined emergency preparedness plan owing to unexpected effects due to road damage, widespread power failure, fuel shortages in monitoring cars, damage to communications networks, and delay in the preparation of helicopters.

Radiation monitoring on land – monitoring posts washed away and communication lines severed

Issue 2: Four of the 24 monitoring posts established by Fukushima Prefecture were washed away by the tsunami and another 19 were unable to transmit data owing to severed communication lines, which resulted in 23 monitoring posts being inoperable.

Tap water monitoring – communication method with public

Isuue 3: After notification on 23 March 2011 to refrain from providing tap water to infants in the 23 wards of Tokyo and the Tama area, the radioactivity concentration in tap water on 24 March decreased to below the regulation value. For this reason, it was announced that tap water may be used without any concern, including for infants. However, since mineral water could not be obtained in many areas, there were actually severe cases whereby people ultimately had to decide for themselves whether to drink tap water including radioactive materials or to refrain from drinking water and whether or not to continue breast feeding owing to concern of transferring radioactive materials from mother to infant. **[the first JHPS recommendations]**

Shipping restrictions and monitoring of agricultural and livestock products – expansion of contamination due to food chain

Issue 4: The Notice on Farming Management was not communicated to grain farmers, who produce rice straw. Furthermore, the information and guidance provided to cattle farmers were inadequate and it was discovered that cattle farmers had fed their cattle rice straw that had been stored outdoors and was most likely contaminated with radioactive material. This led to the detection of radioactive cesium exceeding the temporary regulation value in beef.

Shipping restrictions and monitoring of agricultural and livestock products – measurement method for livestock products

Issue 5: Beef fed by contaminated rice straw could not be identified by inspection after slaughter.

Food monitoring – regional variations

Issue 6: Food monitoring was left to the test plans of the prefectures, so the level of the monitoring varied depending on the prefecture. The monitoring equipment and other infrastructure in the various prefectures were insufficient at the early stage after the

disaster. Moreover, there were also local governments that were unenthusiastic about performing monitoring because of their concerns about the harm to their reputation, so the level of monitoring varied depending on the local government.

Monitoring of forests and subsoils of rivers and lakes – lack of understanding of the necessity

Issue 7: The necessity of monitoring forests and subsoils of rivers and lakes was not sufficiently understood.

Monitoring of seawater, subsoils of ocean, and sea products – lack of understanding of the necessity

Issue 8: Since the necessity of sea area monitoring was not fully understood, the monitoring area was limited to the region within 30km from Fukushima Dai-ichi NPS at the early stage after the accident. Ocean currents formed around this local area were not considered in the monitoring design, which led to missing knowledge on the dynamics of the transition of radioactive materials from the source.

Monitoring of seawater, subsoils of ocean, and sea products – lack of prediction tools

Issue 9: Since the seawater off Fukushima Prefecture travels down to the southern region of the Fukushima Dai-ichi NPS along the coast after the "Oyashio" current meets the "Kuroshio" current, radioactive materials in seawater traveled down to off the coast of Ibaraki Prefecture in the area south of the Fukushima Dai-ichi NPS, which led to the situation that radioactive materials temporarily accumulated in sand eels, forcing fishermen in Ibaraki Prefecture to refrain from fishing. In addition, radioactive materials also accumulated in bottom-dwelling coastal fishes (e.g., flat fish, flounder, etc.). The timing of the accumulation of radioactive materials in medium-sized fish owing to the food chain could not be predicted since the monitoring target at the early stage postaccident was not ocean subsoils but seawater.

System for Prediction of Environmental Emergency Dose Information (SPEEDI) – underutilization of prediction results

Issue 10-1: Since the external power supply was lost following the earthquake and the Government's dedicated line for sending data became unavailable, the release of source information from the Emergency Response Support System (ERSS) on which SPEEDI calculations are based was not carried out. For this reason, the Nuclear Safety Technology Center provided the predicted results of their unit release rate calculation based on "the Environmental Radiation Monitoring Guidelines", to the Ministry of Education, Culture, Sports, Science and Technology (MEXT), the Emergency Response Center (ERC), the Nuclear Safety Commission (NSC), the Off-site Center, the Fukushima Prefectural Office, and the Japan Atomic Energy Agency (JAEA) in response to the directive from MEXT on 11 March 2011. However, these predicted results were neither utilized to discuss practical evacuation measures nor disclosed to the public, since the calculations based on an assumed unit release rate did not show any actual radiation dose levels. [**the first JHPS recommendations**]

Issue 10-2: On the night of 12 March, NSC made one request for a SPEEDI calculation to the Nuclear Safety Technology Center. The NSC received the calculation results and shared them with its members, members of its technical advisory body in an

emergency, and some staff members of the NSC Secretariat. The NSC, however, believed that the calculation results should only be utilized for internal discussion. As a result, the calculation results were not shared with any other organizations.

Issue 10-3: Meanwhile between 11 and 15 March, the Nuclear and Industrial Safety Agency (NISA) conducted SPEEDI calculations by entering various assumptions of release source information in order to grasp the dispersion trend of radioactive materials. The obtained predicted results were shared with various functional teams within the MEXT-ERC. A few results were provided to the Prime Minister's Office and the Off-site Center. However, NISA sent the Prime Minister's Office the SPEEDI predictions with an accompanying message that NISA believed the SPEEDI predictions to be of low reliability because the calculations were based on assumed release source information. Cabinet Secretariat staff treated them as reference information and did not report them to the Prime Minister.

Simulation system on the diffusion of radioactive materials in the ocean – lack of prediction tools in the emergency preparedness system

Issue 11: No simulation system for the diffusion of radioactive materials in the ocean has been established in the nuclear emergency preparedness system, since people do not live on sea area, unlike on land. **[the first JHPS recommendations]**

Evacuation of residents and its criterion – extension of order to stay indoors

Issue 12: The results of radiation monitoring and SPEEDI retrospective estimation showed there were areas with high radiation doses even more than 20km from the Fukushima Dai-ichi NPS. The distribution of essential items was disrupted in stay-indoors evacuation zones and it was difficult for residents to conduct their daily lives. In the Nuclear Emergency Guidelines, the enforcement of a stay-indoors evacuation for a long period of time was not assumed. **[the first JHPS recommendations]**

Evacuation of residents and its criterion – instruction of deliberate evacuation

Issue 13: On 11 April 2013, Chief Cabinet Secretary Edano announced a fundamental concept of how deliberate evacuation zones should be established. Subsequently, the government issued early advice to the affected municipalities and then, on 22 April, the Nuclear Emergency Response Headquarters (NERHQ) established deliberate evacuation zones and provided those municipalities with a directive to inform residents in the zones to be prepared to evacuate after a period of approximately one month. **[the first JHPS recommendations]**

Evacuation of residents and its criterion – communication of evacuation instruction

Issue 14: The Emergency Preparedness Guide prescribes that the head of the local headquarters shall communicate an evacuation order to each municipality, including cities, towns, and villages. Most of the municipalities actually learned of the evacuation instructions through the mass media including TV. Some of them learned through verbal announcements from police vehicles, including police patrol cars.

Evacuation of residents and its criterion – evacuation beyond a designated zone for emergency preparedness

Issue 15: Each of the municipalities located within a 10km radius (equivalent to the Emergency Planning Zone, or EPZ) of a power plant is expected to possess regional disaster prevention plans and evacuation plans. Each municipality is, as a rule, primarily responsible for formulating evacuation plans and implementing these plans, but in the event of evacuation over a wider area (across municipalities), Fukushima Prefecture bears the responsibility of formulating an evacuation plan. However, in reality, the only evacuation cases in which Fukushima Prefecture took the lead in coordinating shelters across municipalities were for Futaba Town and Okuma Town, when an evacuation instruction was issued for areas lying within a 10km radius.

Evacuation of residents and its criterion – evacuation of socially vulnerable individuals

Issue 16: People who had difficulty evacuating, such as hospitalized patients, were left behind in the area within a radius of 20km from the nuclear plant, which had been designated as an evacuation zone. In the situation where communication was limited and sufficient information could not be obtained, the evacuation of hospitalized patients was extremely difficult, resulting in many cases of aggravated medical conditions or death.

Radiological protection criteria – criteria for administration of stable iodide – confusion regarding administration criteria

Issue 17: Local governments were able to obtain a sufficient amount of stable iodine tablets, but instructions to take the stable iodine tablets were not given because there was no information on predicted radiation dose by SPEEDI. On the other hand, new criteria for the administration of stable iodine were provided by the NSC on the basis of a screening level. This advice, however, did not reach Fukushima Prefecture and the cities, towns, and villages concerned. There was no opportunity to take iodine tablets except for some residents who were given instructions at a local government's own discretion. **[the first JHPS recommendations]**

- On 13 March 2013, the NSC advised the ERC that stable iodine tablets should be provided to those who had radiation dose exceeding 10,000cpm detected at at their screening services. However, this information was not communicated to the local NERHQ.

- At 01:25 on 16 March, the NSC distributed advice to the ERC to the effect that all of those remaining within a 20km radius should take stable iodine tablets while being evacuated.

- The local NERHQ, which confirmed this advice via the ERC, issued a written order at 10:35 the same day to the leaders of the Fukushima prefectural government and 12 affected municipalities. However, the Fukushima prefectural government did not follow this instruction on the intake of stable iodine tablets because the government had already confirmed that there were no individuals remaining within a 20km radius.

- The Fukushima prefectural government also asked the ERC and other organizations to help secure stable iodine tablets and was able to obtain approximately 1,360,000 stable iodine tablets from a major stable iodine manufacturer and from the Ibaraki prefectural government. On 14 March, the Fukushima prefectural government reached the decision to distribute two stable iodine tablets to each resident under 40 years of age in all municipalities within an approximate radius of 50km of the nuclear power station. However, the Fukushima prefectural government did not give instructions to each city, town, and village concerned to

take iodine tablets, despite having the authority to do so.

- During the night of 14 March, Miharu town officials had fears that its residents might be exposed to radiation and decided to distribute stable iodine tablets to its residents and instructed them to take the tablets. At 13:00 on 15 March, Miharu town officials, using a municipal disaster management radio communication network, made sure that each and every resident was informed of this decision. They distributed stable iodine tablets to approximately 95% of residents under the supervision of local pharmacists. Later, staff of the Fukushima prefectural government learned that the Miharu town office had distributed stable iodine tables and instructed the residents to take them. In the evening of the same day, the staff instructed Miharu town officials to stop distributing stable iodine tablets and to retrieve all of them as there had been no instructions from the national government. Miharu town officials did not obey this order.

Radiological protection criteria – screening level – validity of the level

Issue 18: The screening level was raised in accordance with the present situation using different levels from those that had been previously established. **[the first JHPS recommendations]**

- The "Manual for Radiation Emergency Medical Care Activities in Fukushima Prefecture," which was created under the authority of the Fukushima prefectural government, was based on a manual entitled "Recommendation on Radiation Emergency Medical Care", which was prepared by the NSC, and stipulated that the screening level for residents (a criterion of comprehensive outer body clean up) should be 40Bq/cm^2. The Fukushima prefectural government set the screening level at count rates of 13,000cpm (counts per minute), which is equivalent to about 40Bq/cm^2 and started to implement screening services on 12 March 2011.

- The Local NERHQ asked the ERC for advice in the morning of 13 March regarding setting the criterion of 40Bq/cm^2 or 6,000cpm. The ERC requested comments from the NSC on the criterion. The NSC responded that the screening level of 6,000cpm should be revised to 10,000cpm and that those who experienced exposure in excess of 10,000cpm should take stable iodine tablets; however, these comments were not communicated to the Local NERHQ by the ERC.

- Radiology experts in a radiation emergency medical care team dispatched to Fukushima Prefecture on 13 March voiced the opinion that the screening level should be raised from 40Bq/cm^2 (13,000cpm) to 100,000cpm, after considering that water (hot water) to be used for whole-body decontamination (showering) appeared to be in short supply and that whole-body decontamination under low-temperature conditions is believed to have major disadvantages.

- The Fukushima prefectural government decided to raise the screening level to 100,000cpm for whole-body decontamination from 14 March onward and also conducted partial wipe-off decontamination for those with a count rate of 13,000cpm to less than 100,000cpm.

- Before dawn on March 14, having learned that the Fukushima prefectural government was raising the screening level, the NSC provided the ERC with advice to the effect that "it is desirable not to raise the screening criterion to 100,000cpm and to keep it at the current value of 13,000cpm." However, the Fukushima prefectural government decided to continue with the screening and decontamination with a screening criterion of 100,000cpm, as it judged that the new screening level and decontamination methods would not go against the NSC advice because they involved partial wipe-off decontamination of those with a count rate of

13,000cpm to less than 100,000cpm.

- Subsequently, the NSC received the request that "it would be desirable to raise the screening level to 100,000cpm, as the air dose rate is high in the affected areas and screening is difficult to conduct." Accepting the request, the NSC, at 14:40 on 19 March, provided the ERC with the advice that the screening level should be raised to 100,000cpm ("Recommendation on Screening Criteria of Radiation Emergency Medical Care").

Radiological protection criteria – criteria for contamination of soil (schoolyards and educational facilities, and bathing areas, utilization of crushed stones, and disposal of disaster waste and sewage sludge) – consistency of concepts for derivation of criteria

Issue 19: It has become difficult to explain the consistency among all the criteria since each criterion was determined using a different concept. **[the first JHPS recommendations]**

- The value of 3.8μSv/h for ambient dose rate, which was announced by MEXT in "Provisional view regarding the judgment of the use of schoolyards and educational facilities in Fukushima Prefecture" was derived using 20mSv/y, which is the upper limit in the band of reference level established by the International Commission on Radiological Protection (ICRP) for an existing exposure situation. Subsequently, MEXT decided to aim to reduce the level of contamination to 1mSv/y.

- The provisional criterion for bathing areas announced by the Ministry of the Environment (MOE) was derived such that the individual dose due to external and internal exposure would be within 10% of 1mSv/y.

- The concept of the reference level established by the ICRP for an existing exposure situation was not applied to the criteria of utilization of crushed stones and disposal of disaster waste and sewage sludge. These criteria were derived from "Near-term policy to ensure the safety for treating and disposing of contaminated waste around the site of Fukushima Dai-ichi Nuclear Power Station of Tokyo Electric Power Company" (control not to exceed 1mSv/y for residents and workers and 10μSv/y for the public in the case of recycling exposure scenario) announced by the NSC on 3 June 2011.

Radiological protection criteria – criteria for food and beverages - comprehensiveness of food categories

Issue 20: Since in the provisional regulatory values (by 31 March 2012) for radioactive materials contained in foods, the restriction values for radioactive iodine in fish and foods not to consumed directly, e.g., tea leaves, were not specified, much confusion occurred. **[the first JHPS recommendations]**

Radiological protection criteria – criteria for food and beverages – universal use for various types of accident

Issue 21: Since the new regulatory value for food and beverages enforced on 1 April 2012 was derived for only radioactive cesium on the basis of 1mSy/y as an internal exposure dose and can be applied to the current situation after the present accident, it cannot be universally used as a criterion for emergency preparedness where various types of accident should be considerd.

Radiological protection criteria – criteria for food and beverages – approach to dose criteria

Issue 22: In the derivation of the new regulatory value for food and beverages enforced on 1 April 2012, 1mSv was adopted as a dose criterion, strictly shifting from 5mSv; nevertheless, the estimated dose due to intake of contaminated foods was sufficiently low and was determined without full discussion with stakeholders associated with the production, distribution, and consumption of foods. **[the first JHPS recommendations]**

Radiological protection criteria – protective criteria for temporary entry into restricted zones - balance among other risks

Issue 23: Irrespective of the ambient dose level in the residence, the maximum time spent at home during temporary entry was limited to 2 h, and the total time taken for the round trip from the relay point to each home was limited to 5 h. **[the first JHPS recommendations]**

Radiological protection criteria – dose criteria for emergency work – dose limit taking life-saving work into account

Issue 24: In the second interim report on the incorporation of the 2007 Recommendations of the ICRP into domestic systems, the Basic Committee of the Radiation Council proposed to match the dose limits to internationally recommended values, taking into consideration that opportunities to participate in international activities were increasing for domestic workers, because the current restriction criteria in Japan (dose limit, 100 mSv) interfered with emergency medical care and other essential operations. On the other hand, in response to the present accident, 250mSv was adopted as a dose limit for emergency workers. This value is lower than the internationally approved principles and the recommended value of the 2007 Recommendations of ICRP (emergency medical care, no restriction; other emergency rescue operations, 1,000 or 500 mSv; other rescue operations, 100 mSv). **[the first JHPS recommendations]**

Radiological protection criteria – dose criteria for emergency work – treatment of individual doses received in an emergency situation

Issue 25: In the second interim report on the incorporation of the 2007 Recommendations of the ICRP into domestic systems, it was indicated that emergency work doses will be treated separately from normal work doses. However, the Ministry of Health, Labor and Welfare (MHLW) issued an official notice stating that when managing dose limits during normal work, if a worker has a history of engaging in emergency work, the doses received during such work should be included and the limit of 100mSv/5 years should be applied. **[the first JHPS recommendations]**

Radiation exposure of residents – estimation of thyroid equivalent dose of radioactive iodine by simple measurement

Issue 26: Screening tests for thyroid gland exposure levels on 1,080 infants and children were carried out in Iwaki City, Kawamata-machi, and Iitate-mura from 26 March to 30 March 2011; however, this involved low-precision tests and no further tests of the thyroid gland exposure levels of the children were carried out. **[the first JHPS recommendations]**

Radiation exposure of residents – internal dose assessment using whole body counter (WBC) – investigation system

Issue 27: As part of the Fukushima Prefecture Health Management Survey started in June 2011, individual doses for external exposure were investigated as the External Dose Estimation based on the behavior records in the Basic Survey. However, investigation of the dose for internal exposure using the WBC was not carried out in the Basic Survey. For this reason, the WBC measurement results are individually kept in each municipality or hospital since these data are a form of personal information that is unavailable for use for other objectives without permission. The WBC measurement for internal exposure was not addressed in the nuclear emergency preparedness plan, which was a main cause of the delay in conducting the WBC measurement.

Radiation exposure of residents – internal dose assessment using whole body counter (WBC) – measurement method

Issue 28: Since individual dose assessment for internal exposure using the WBC highly collected the needs of residents, the WBCs were individually set up by municipalities, hospitals, and nongovernmental organizations, in addition to direct management by the Fukushima prefectural government. Therefore, the dose assessment was carried out by nonunified methods without standardization. **[the first JHPS recommendations]** Although it is important, when using a great number of WBCs as a monitoring tool, to ensure the traceability from the viewpoint of maintaining the reliability of the measurements, there are no standards for WBCs. Also, there are no manuals to effectively explain the WBC monitoring results to the public.

Radiation exposure of residents – external dose assessment using personal dosimeters

Issue 29: Since dose assessment was carried out by each municipality by lending personal dosimeters in response to the needs of residents, individual dose data for external exposure are kept in the respective municipality because these data are a form of personal information that is unavailable for use for other objectives without permission.

Radiation exposure of residents – external dose estimation on the basis of behavior survey

Issue 30: As part of the Fukushima Prefecture Health Management Survey started in June 2011, the individual dose for external exposure was investigated as the External Dose Estimation, using the behavior records obtained via sets of inquiry forms in the Basic Survey. However, the recovery ratio of inquiry forms was only 18% in December 2011. (As of 31 January 2013, the recovery ratio for the whole area of the prefecture was 23.2% and that for the preceding investigation area, Yamakiya district of Kawamata Town, Namie Town, and Iitate Village was 56.7%)

Radiation exposure of plant recovery workers – network for urgently borrowing alarm pocket dosimeters (APDs)

Issue 31: Although many APDs were provided as aid supplies from other NPSs, these APDs were simply stored and remained unused owing to a lack of communication. There were not enough APDs and by 15 March, not every worker was able to wear an APD, which led to the decision that only the leaders of each operational group would wear APDs on behalf of the entire group.

Radiation exposure of plant recovery workers – control of internal exposure in an emergency

Issue 32-1: The individual doses of 6 workes exceeded 250mSv, which was the dose limit for emergency workers temporarily prescribed after the accident.

- The main control room outside the controlled areas was not equipped with a sufficient number of full-face masks. In addition, since the number of charcoal filter masks was not sufficient for all of the workers, some staff members just wore dust filter masks until charcoal filter masks were delivered from the Seismic Isolation Building in the evening of 12 March.

- There were actual cases in which staff members sometimes ate and drank in the main control room without wearing masks, sometimes took their masks off and spent short periods of time without them, and sometimes loosened their masks because their breath fogged up their masks or their masks were too tight, causing headaches. Moreover, there was a possibility that the arms of glasses created a gap between the face and the mask.

- The emergency doors to and from the main control rooms of Units 1 and 2, which had been bent and twisted by the blast from the hydrogen explosion in Unit 1, were only temporarily sealed with vinyl sheets. Meters on the side of Unit 1 were located in a stream of air flowing from the emergency doors. In the main control room of Units 3 and 4, some staff members also spent most of their time checking the meters nearest the emergency doors, which were bent and twisted by the blast of the explosion.

- Some staff members in the main control room of Units 3 and 4 did not take stable iodine tablets until they moved to the Seismic Isolation Building on the evening of 13 March.

- Since the ambient dose in the whole body counter (WBC) room became higher following the accident, those WBCs could not be used. From 22 March, TEPCO borrowed vehicle-mounted WBCs, which were installed at the Onahama Call Center, and internal exposure tests of the workers were commenced.

- When a high contamination was observed, personal decontamination was carried out to remove external contamination. Since the worker then needed to wait for approximately two weeks to receive a test purely for internal exposure, it took time to assess the high-level internal exposure.

Issue 32-2: The doses of two female employees significantly exceeded the 5mSv three-month upper limit for female radiation workers, although they took appropriate radiological protection measures such as wearing full-face masks with charcoal filters whilst working in the field, since the double-entry doors to the Seismic Isolation Building were not airtight and the doors to the Seismic Isolation Building were bent and twisted by the hydrogen explosions in Units 1 and 3.

Issue 32-3: 178 workers showed thyroid gland equivalent doses of over 100mSv, and 25 workers under the age of 40 did not take iodine tablets.

Radiation exposure of plant recovery workers – control of localized exposure in an emergency

Issue 33: On 24 March, two of three workers who were installing electric cables under the surface of the basement floor of the Unit 3 turbine building were exposed to high radiation doses while working immersed in contaminated water, because they were

wearing low quarter shoes. Although it was made clear, after getting cleaned up and having a checkup and getting tested to measure internal radiation doses, that neither worker suffered radiation heat burns on their feet, there had been a possibility of suffering from radiation heat burns due to continuous localized exposure.

Radiation exposure of plant recovery workers – managing access to and from a controlled area in an emergency

Issue 34-1: After the nuclear accident, access to and from the controlled area of the management system was initially impossible for calculating the radiation dose of individual radiation workers. It was then decided to manually calculate the radiation dose of individual radiation workers using APDs. (On 14 April, five simplified instruments were installed in the Seismic Isolation Building for gaining access to and from the controlled area management system. At the same time, a radiation work permit with bar code patterns was introduced so that the names and radiation doses of individual workers could be automatically recorded).

Issue 34-2: From the date of the nuclear accident to 10 May, radiation workers were allowed to carry out their duties after receiving a brief 30-minute explanation about how to protect themselves from radiation and how to wear protective equipment.

Communication to the public – spreading understanding of radiation effects

Issue 35: The Government often explained, "It does not have immediate effects on health", concerning the influence of radiation on the human body. This expression may be interpreted by some people as "it is unnecessary to be anxious about the impact of radiation on human health," while it may be interpreted by other people as "it does not immediately affect human health, however, some effects on human health will appear in the longer term." However, it was not necessarily clear what the intended meaning of the expression was, and there was no detailed explanation. Moreover, anxiety regarding unknown nuclear disasters and dissatisfaction about the explanation from the government were broadly shared. One of the reasons for this is that we have neglected to endeavor to improve public understanding of radiation and have never trained radiological protection experts for communication in the municipal government in the nuclear emergency preparedness plan.

Communication to the public – comprehensibility of radiological protection system

Issue 36: Residents who had to live in an environment contaminated by radioactive material after the accident sought information about the level of radioactivity that would serve as a basis for making decisions. Mothers, in particular, sought accurate information about the extent of contamination in the food and beverages they were giving their children, and about the radiation dose from the environment and its potential effects on their health. However, the information that was made available to the residents was not satisfactory. **[the first JHPS recommendations]**

Communication to the public – utilization of mass media

Issue 37: The government rapidly responded to online communication by consolidating the relevant information onto its homepage and opening an official twitter account of the Cabinet. However, it used only one way communication such as mass media and could not provide appropriate timely information or gain the public's confidence, since the information was not obtained through bidirectional exchanges utilizing the

characteristics of social media.

Communication to the public – response to foreign residents and overseas countries

Issue 38-1: Although the discharge of the less contaminated water into the sea conducted on 4 April 2011 did not fall within the scope requiring notification prescribed in the United Nations Convention on the Law of the Sea, the notification stating that the discharge would begin was sent the day of discharge after it had already started and countries around Japan were not informed of the discharge in advance.

Issue 38-2: The U.S. Nuclear Regulatory Commission (NRC) had been seeking detailed information regarding the status of the Fukushima Dai-ichi NPS from the Japanese government since 12 March 2011. However, the Japanese government was incapable of providing such information to the U.S. in a manner satisfactory to the U.S. side, because Japanese government had not been able to acquire sufficient information on the nuclear power plant itself and officials of NISA and other government staff familiar with the situation at the nuclear plant were preoccupied with their work of dealing with the plant's situation. For this reason, the NRC decided to issue evacuation advice as a safety measure, and on 17 March (Japan time) advised U.S. citizens in Japan to evacuate to outside of a 50-mile (about 80km) radius of the Fukushima Dai-ichi NPS. This led to confusion because this radius for evacuation was significantly larger than the 20km radius of the Japanese evacuation area.

Nuclear emergency preparedness system – preparedness for complex disasters

Issue 39: Serious confusion occurred in the relevant organization owing to insufficient preparedness for an accident scenario where events unfold quickly and for facing a complex disaster involving earthquakes and tsunamis occurring simultaneously with a nuclear disaster.

- The central organization of the government's emergency response system is the NERHQ (the Prime Minister and the Minister of Economy, Trade and Industry (METI) serve as the director-general and the deputy director-general, respectively). The secretariat of the NERHQ was established at NISA-ERC and was expected to monitor the nuclear facilities' conditions and coordinate emergency response measures, such as the evacuation of residents. They were unable to perform those anticipated roles, largely because the secretariat of the NERHQ failed to collect and share information concerning the progression of the accident and the progress of the response, and partly because the *Kantei* (the Prime Minister and other concerned parties who assemble in the prime minister's office and reception rooms on the fifth floor of the *Kantei*) stepped in to lead the government's response to this accident as the situation of the accidental events evolved extremely rapidly.

- The Local NERHQ (the deputy minister of METI serves as the director-general), to which the NERHQ delegates part of its authority, is responsible for the response to the accident, including the issuance of evacuation orders, in accordance with the actual local conditions and with the support of the NERHQ and the support and cooperation of the other relevant organizations such as municipal governments. The establishment of the organizations that needed to be set up at the Off-site Center (the center for emergency response measures) for this accident required much time owing to the delays and cancellations of the arrivals of necessary personnel (including the director-general of the Local NERHQ), as well as the earthquake's impact on facilities and equipment. The effective establishment of the Local NERHQ was delayed until around 3:00 on 12 March, when the emergency generator at the Off-site Center resumed normal operations. Feeling a sense of crisis, Fukushima Prefecture

took its own initiative to issue an evacuation order for a radius of 2km from the Fukushima Dai-ichi NPS. Thirty minutes later, the national government issued an evacuation order for residents within a 3km radius of the plant. In this emergency situation, the Off-site Center failed to adequately perform its expected functions.

- Following the expansion of the evacuation zone beyond a 10km radius of the Fukushima Dai-ichi NPS, the Off-site Center (located within a 5km radius of the plant) became isolated in the evacuation zone, making it difficult to procure fuel, food and other necessary supplies. As the Off-site Center was not equipped with air filters to block the penetration of radioactive materials, radiation doses within the building increased in tandem with the rises in radiation doses in surrounding areas, and on 15 March, it was decided to relocate the Off-site Center to the Fukushima prefectural government building.

- The Emergency Response Office in the Prime Minister's Office (Crisis Management Center) was meant to engage in the initial response following the outset of a nuclear disaster up to the point when the NERHQ begins full-fledged operations. Once the activities of NERHQ and its secretariat began in earnest, it was assumed that operations would be handed over to the secretariat of the NERHQ. However, the politicians in the *Kantei*, including Prime Minister Kan, moved to a small room on the mezzanine floor and then to the area surrounding the Office of the Prime Minister on the fifth floor of the *Kantei*, because the operation room was in uproar and they were not comfortable making decisions in such a place. This caused disruption in the flow of information with the Crisis Management Center.

- As an expert body on nuclear power in the nuclear emergency preparedness activities, NSC is meant to provide appropriate advice based on requests made by the director-general of the NERHQ, or the prime minister. According to the Basic Plan for Emergency Preparedness, NSC is to set up a headquarters organization, called an emergency technical advisory body, within its secretariat, as well as a local body of the emergency technical advisory body at the Off-site Center to which it will dispatch the NSC commissioners and the advisors for emergency responses. In turn, NSC is to collect information and perform investigations and analyses, as well as prepare technical advice. However, owing to disruptions in public transportation and telecommunications, nearly all of the advisors for emergency responses that were summoned failed to convene on 11 March. During the initial response, members of NSC and advisors for emergency responses were not dispatched to the site, nor were any local bodies established at the Off-site Center.

- After the NSC Chairman attended the first meeting of NERHQ on 11 March 2011, following a request made by the *Kantei*, he remained almost continuously assigned to the *Kantei* until around 15 March, together with the NSC Deputy Chairman, and offered advice grounded in technical expertise, on the basis of the plant information that had been collected. However, this advice was not offered as advice from NSC as an organization. With the prolonged absence of two of its five members as well as its secretary general, NSC was significantly impaired in its function as an organization.

- According to the MEXT Emergency Action Plan, MEXT must establish a Nuclear Emergency Response Support Headquarters within the ministry, mainly to provide advice for monitoring conducted by the Off-site Center radiation squad, to analyze monitoring data, and to dispatch disaster medical assistance teams to the site. MEXT and other relevant organizations are to dispatch personnel and equipment to local governments to support emergency monitoring activities undertaken by the local governments. On 12 March 2011, MEXT decided to dispatch monitoring vehicles and personnel to the Off-site Center, but the MEXT's support team did not begin monitoring activities until 15 March. Owing to a shortage of fuel and other

supplies for monitoring vehicles, when the Local NERHQ moved to the Fukushima Prefectural Government Building on 15 March, the team was forced to leave the monitoring vehicles that had run out of fuel at the Off-site Center.

- A Prefectural Headquarters for Disaster Control was to be established at the Fukushima Prefectural Government offices (Main office fifth floor) and the Prefectural Nuclear Emergency Response Headquarters was to be formed at the Off-site Center. Nine squads were to be established under the Prefectural Headquarters for Disaster Control to gather information and provide assistance to municipal governments for resident evacuation. However, a large number of personnel at the Fukushima Prefectural Office were working on the various functional squads at the Fukushima Prefecture Headquarters for Disaster Control, in order to implement earthquake and tsunami countermeasures. Fukushima Prefecture therefore hastily established a new nuclear squad, which was devoted to the nuclear disaster response. However, responses of the nuclear squad fell into a state of confusion owing to the ineffectiveness of the Off-site Center. The Fukushima Prefecture Headquarters for Disaster Control had to oversee operations that it had not foreseen, including, for instance, securing truck-mounted generators requested by TEPCO and screening evacuated residents.

- The main office of the Fukushima prefectural government building, established as the Fukushima Prefecture Headquarters for Disaster Control, was due to undergo anti-seismic reinforcement construction because its seismic resistance was low, but at the time of the disaster, improvements had yet to be made. Fukushima Prefecture then transferred the necessary equipment to the third floor of the Fukushima Prefecture Public Hall, a building designated as an alternate facility. This building, however, only had two municipal disaster management radio communication lines—a vital communication network during times of emergency—whereas the main office of the prefectural government building was equipped with 47. Communication networks between the prefectural and municipal governments and other agencies were fragile, which created major obstacles in responding to damage caused by the earthquake and tsunami as well as the nuclear disaster.

- Following the disaster, Fukushima Prefecture dispatched personnel to an Off-site Center and established the Prefectural Nuclear Emergency Response Headquarters, but the officials were unable to fulfill their assumed role. This was because no substantial discussions took place in the Prefectural Nuclear Emergency Response Headquarters and the Joint Council for Nuclear Emergency Response, particularly after 14 March, since the personnel were occupied with preparations to transfer the Off-site Center to the Fukushima Prefectural Government office as events unfolded quickly in this accident.

Nuclear emergency preparedness system – opportunity of revision of nuclear emergency preparedness for complex disasters (earthquake, tsunami, and nuclear accident)

Issue 40: Although problems of emergency preparedness assuming the possible occurrence of a nuclear emergency coupled with a complex disaster were pointed out, no measures were taken against them.

- Upon requests from the Niigata prefectural government, following the occurrence of a fire at the Kashiwazaki-Kariwa NPS when it was struck by the Niigata-ken Chuetsu-oki Earthquake, the national government requested the investigation committee on the accident at the Kashiwazaki-Kariwa NPS to examine and report on the issue of preparedness against a nuclear emergency coupled with a complex disaster. The report produced by the investigation committee stated the government's intention to resolve the issues that require attention when responding to a nuclear emergency in a complex disaster under the leadership of NISA.

- However, the draft document entitled “A Draft on the Issues Requiring Attention When Preparing an Emergency Response Manual for Nuclear Emergency Coupled with Complex Disaster” submitted by NISA in April 2009, stated that the probability of a nuclear emergency being coupled with a complex disaster was extremely small, on the basis of the view that nuclear power facilities employ a seismic structural design and are technologically well protected against earthquakes on a design basis level, as well as the view that the incident that had taken place at the Kashiwazaki-Kariwa NPS as a result of the Niigata-ken Chuetsu-oki Earthquake fell short of being a nuclear emergency. Therefore, the draft document concluded that it was reasonable to develop countermeasures on the basis of ongoing organizational arrangements for disaster prevention and negated the need to make new organizational arrangements for disaster prevention assuming the possible occurrence of a nuclear emergency coupled with a complex disaster.

- The draft document received the following criticisms, which argued against the very act of developing countermeasures against a nuclear accident coupled with a complex disaster, from concerned agencies of the national government and local governmental organizations:

  (i) The development of countermeasures against a nuclear emergency in a complex disaster may become a cause of the mistaken view that major natural disasters are likely to initiate a nuclear emergency;

  (ii) The implementation of countermeasures against a nuclear emergency in a complex disaster will require major modifications to regional disaster prevention plans, etc.; or

  (iii) There has not been sufficient negotiation with concerned organizations for affairs to be handled by an organization other than NISA.

- In response to such criticisms, NISA revised the draft from scratch in October 2010, specifying that (i) NISA would consult with the Cabinet Office to discuss a future implementation plan with the Central Disaster Prevention Council and that (ii) further assistance should be provided to local governments to compensate their insufficient resources in dealing with complex disasters. A specific discussion on (ii) was held as late as 28 February 2011. Also, it was not until 8 March 2011 that NISA consulted with the Cabinet Office concerning (i). In response to this approach from NISA, the managers of the Cabinet Office answered that the matter should be handled by NISA, since complex disasters were related to nuclear issues and could not be worked on by the Central Disaster Prevention Council.

- The national government and municipal governments, by sticking to the existing nuclear disaster prevention framework and their traditional means of planning for disaster preparedness, hampered quick revision of the draft, leaving in place measures that were insufficient to provide for the safety of local residents.

- It had been pointed out, as a result of the administrative evaluation/monitoring by the Ministry of Internal Affairs and Communications (MIC) in February 2009, that measures would be needed to reduce exposure to doses of radiation within the Off-site Center in the event of a nuclear accident. Nonetheless, NISA failed to take adequate measures.

Radiological protection measures postaccident have different aspects depending on whether the target is the public or workers. For the public, the residential area is the

surrounding area or far from the accident site. Workers are plant recovery or rescue/decontamination workers around the accident site, and the timing to implement the radiological protection measures is the early stage (up to 1 week postaccident), middle stage (up to 1 month postaccident), later stage (up to 1 year postaccident) or long-term stage (after 1 year postaccident). For this reason, the radiological protection measures were arranged in a matrix format including these categorizations. Also, where the above-mentioned 40 issues are addressed in the matrix was clarified.

The locations of the issues in the matrix of the radiological protection measures postaccident are shown in Table 2.4.1 for the public and Table 2.4.2 for workers. The relevant issues are given within parentheses [ ].

Table 2.4.1 Locations of issues for the public in the matrix of the radiological protection measures postaccident.

Stage post accident	Protective measures postaccident for the public	
	Surrounding area	Remote area
Early stage (up to 1 week postaccident)	Radioactive plume ・ Evacuation/stay in house [**Issue 12, 14-16**] ・ Prediction of air diffusion [**Issue 10**] ・ Administration of stable iodine [**Issue 17**]	Radioactive plume ・ Prediction of air diffusion [**Issue 10**]
	Leak of contaminated water ・ Prediction of diffusion in sea [**Issue 11**]	Leak of contaminated water ・ Prediction of diffusion in sea [**Issue 11**]
	Environmental monitoring ・ Monitoring on land [**Issue 1-2, 7]** ・ Monitoring for sea [**Issue 8-9**]	Environmental monitoring ・ Monitoring on land ・ Monitoring for sea [**Issue 8-9**]
	Prevention of contamination expansion ・ Screening level for decontamination [Issue **18**]	
	Food and beverages ・ Restriction of shipping and intake [**Issue 20-22**] ・ Monitoring [**Issue 3, 6**]	Food and beverages ・ Restriction of shipping and intake [**Issue 20-22**] ・ Monitoring [**Issue 3, 6**]
Middle stage (up to 1 month postaccident)	Environmental monitoring ・ Monitoring on land [**Issue 1-2, 7**] ・ Monitoring for sea [**Issue 8-9**]	Environmental monitoring ・ Monitoring on land [**Issue 1-2, 7**] ・ Monitoring for sea [**Issue 8-9**]

	Dose reduction ・ Mapping contaminated soil ・ Dose assessment [**Issue 26-30**] ・ Modification of evacuation area [**Issue 13**] ・ Temporary access to restricted area [**Issue 23**] ・ Measurement of thyroid equivalent dose [**Issue 26**] ・ Decontamination (living space for children) ・ Communication [**Issue 35-38**]	Dose reduction ・ Mapping contaminated soil ・ Dose assessment [**Issue 27-30**] ・ Decontamination (living space for children) ・ Communication [**Issue 35-38**]
	Prevention of contamination expansion ・ Screening level for decontamination [**Issue 18**] ・ Criteria for contamination of soil, etc. [**Issue 19**]	Prevention of contamination expansion ・ Criteria for contamination of soil, etc. [**Issue 19**]
	Food and beverages ・ Restriction of shipping and intake [**Issue 20-22**] ・ Monitoring [**Issue 3-6**]	Food and beverages ・ Restriction of shipping and intake [**Issue 20-22**] ・ Monitoring [**Issue 3-6**]
Later stage (up to 1 year postaccident)	Environmental monitoring ・ Monitoring on land ・ Monitoring for sea [**Issue 8-9**]	Environmental monitoring ・ Monitoring on land ・ Monitoring for sea [**Issue 8-9**]
	Recovery in short-term range ・ Dose assessment [**Issue 27-30**] ・ Modification of evacuation area [**Issue 13**] ・ Temporary access to restricted area [**Issue 23**] ・ Decontamination (living space) ・ Communication [**Issue 35-38**]	Recovery in short-term range ・ Decontamination (living space) ・ Communication [**Issue 35-38**]
	Prevention of contamination expansion ・ Screening level for decontamination [**Issue 18**] ・ Criteria for contamination of soil, etc. [**Issue 19**]	Prevention of contamination expansion ・ Criteria for contamination of soil, etc. [**Issue 19**]
	Food and beverages ・ Restriction of shipping and cropping [**Issue 20-22**] ・ Monitoring [**Issue 3-6**]	Food and beverages ・ Restriction of shipping and cropping [**Issue 20-22**] ・ Monitoring [**Issue 3-6**]
Long-term stage (after 1 year postaccident)	Environmental monitoring ・ Monitoring on land ・ Monitoring for sea [**Issue 8-9**]	Environmental monitoring ・ Monitoring on land ・ Monitoring for sea [**Issue 8-9**]
	Recovery in long-term range ・ Dose assessment [**Issue 27-30**] ・ Modification of evacuation area [**Issue 13**] ・ Temporary access to restricted area [**Issue 23**] ・ Decontamination (living space, soil and forests) ・ Communication [**Issue 35-38**]	Recovery in long-term range ・ Decontamination (living space, soil and forests) ・ Communication [**Issue 35-38**]

	Prevention of contamination expansion ・ Screening level for decontamination [**Issue 18**] ・ Criteria for contamination of soil, etc. [**Issue 19**]	Prevention of contamination expansion ・ Criteria for contamination of soil, etc. [**Issue 19**]
	Food and beverages ・ Restriction of shipping and cropping [**Issue 20-22**] ・ Monitoring [**Issue 3-6**]	Food and beverages ・ Restriction of shipping and cropping [**Issue 20-22**] ・ Monitoring [**Issue 3-6**]

Table 2.4.2 Locations of the issues for workers in the matrix of the radiological protection measures postaccident.

Stage postaccident	Protective measures postaccident for workers	
	Plant recovery workers	Rescue/decontamination workers
Early stage (up to 1 week postaccident)	External exposure ・ Ensuring personal dosimeters [**Issue 31, 33**] ・ Recording and storage of individual dose data[**Issue 34**]	External exposure ・ Ensuring personal dosimeters ・ Recording and storage of individual dose data
	Internal exposure ・ Administration of stable iodine [**Issue 32**] ・ Ensuring mask and protective wear [**Issue 32**] ・ Ensuring WBC [**Issue 31**] ・ Recording and storage of individual dose data [**Issue 34**]	Internal exposure ・ Administration of stable iodine ・ ・ Ensuring mask and protective wear ・ Ensuring WBC ・ Recording and storage of individual dose data
	Prevention of contamination expansion ・ Screening level for decontamination [**Issue 18**]	Prevention of contamination expansion ・ Screening level for decontamination
	Dose reduction ・ Dose limitation in emergency [**Issue 24**]	Dose reduction ・ Dose limitation in emergency
Middle stage (up to 1 month postaccident)	External exposure ・ Ensuring personal dosimeters [**Issue 31, 33**] ・ Recording and storage of individual dose data [**Issue 34**]	External exposure ・ Ensuring personal dosimeters [**Issue 31, 33**] ・ Recording and storage of individual dose data [**Issue 34**]
	Internal exposure ・ Ensuring mask and protective wear [**Issue 32**] ・ Ensuring WBC [**Issue 31**] ・ Recording and storage of individual dose data [**Issue 34**]	Internal exposure ・ Ensuring mask and protective wear ・ Ensuring WBC ・ Recording and storage of individual dose data
	Prevention of contamination expansion ・ Screening level for decontamination [**Issue 18**]	Prevention of contamination expansion ・ Screening level for decontamination
	Dose reduction ・ Dose limitation in emergency [**Issue 24**]	Dose reduction ・ Dose limitation in emergency

Later stage (up to 1 year postaccident)	External exposure ・ Ensuring personal dosimeters ・ Recording and storage of individual dose data	External exposure ・ Ensuring personal dosimeters ・ Recording and storage of individual dose data
	Internal exposure ・ Ensuring mask and protective wear ・ Ensuring WBC ・ Recording and storage of individual dose data	Internal exposure ・ Ensuring mask and protective wear ・ Ensuring WBC ・ Recording and storage of individual dose data
	Prevention of contamination expansion ・ Screening level for decontamination [**Issue 18**]	Prevention of contamination expansion ・ Screening level for decontamination
	Dose reduction ・ Dose limitation in emergency [**Issue 24**]	Dose reduction ・ Dose limit and ALARA projected dose
Long-term stage (after 1 year postaccident)	External exposure ・ Ensuring personal dosimeters ・ Recording and storage of individual dose data	External exposure ・ Ensuring personal dosimeters ・ Recording and storage of individual dose data
	Internal exposure ・ Ensuring mask and protective wear ・ Ensuring WBC ・ Recording and storage of individual dose data	Internal exposure ・ Ensuring mask and protective wear ・ Ensuring WBC ・ Recording and storage of individual dose data
	Prevention of contamination expansion ・ Screening level for decontamination [**Issue 18**]	Prevention of contamination expansion ・ Screening level for decontamination
	Dose reduction ・ Dose limit and ALARA projected dose [**Issue 25**]	Dose reduction ・ Dose limit and ALARA projected dose

The following results can be derived from the above arrangement of the issues in accordance with radiological protection measures, as shown in Tables 2.4.1 and 2.4.2.

- Two issues, **Issue 39**: Nuclear emergency preparedness system – preparedness for complex disasters and **Issue 40**: Nuclear emergency preparedness system – opportunity of revision of nuclear emergency preparedness for complex disasters (earthquake, tsunami, and nuclear accident), were developed regarding the whole of the emergency preparedness plan; therefore, it was difficult to address any radiological protection measures postaccident.
- The other 38 issues could be obviously connected to radiological protection measures postaccident.
- In the issues from the viewpoint of radiological protection for the public, the issue involving the characteristic that recommendations should differ between surrounding and remote areas was **Issue 35**: Communication to the public – spread of understanding of radiation effects.
- In the issues from the viewpoint of radiological protection for workers, the issue involving the characteristic that recommendations should be prepared for both plant recovery and rescue/decontamination workers was **Issue 31-32**: Radiation exposure of

plant recovery workers.

- Issues involving the characteristic that recommendations should differ among stages postaccident (early, middle, later and long-term) were **Issue 18**: Radiological protection criteria –screening level – validity of the level and **Issue 35**: Communication to the public – spread of understanding of radiation effects.
- Three radiological protection measures regarding monitoring on land, mapping contaminated soil, and decontamination did not have any relevant issues associated with radiological protection.

On a basis of the above results, recommendations shall be developed in the next chapter as follows.

- Difference among stages postaccident (early, middle, later and long-term) should be considered in developing recommendations regarding **Issue 18**: Radiological protection criteria –screening level – validity of the level.
- Differences between surrounding and remote areas and among stages postaccident (early, middle, later and long-term) should be considered in developing recommendations regarding **Issue 35**: Communication to the public – spread of understanding of radiation effects.
- Recommendations for rescue/decontamination workers should be involved in those regarding **Issue 31-32**: Radiation exposure of plant recovery workers.

3. Recommendations from the viewpoint of radiological protection

3.1 Recommendations for protection of the public

In this section, recommendations are described in response to issues highlighted in the previous chapter from the viewpoint of radiological protection of the public. In the drafting of the recommendations, comments made at the JHPS symposia, as described in section **2.3**, were incorporated. On the basis of the results obtained in the previous chapter, recommendations regarding **Issue 18**: Radiological protection criteria – screening level – validity of the level and **Issue 35**: Communication to the public – spread of understanding of radiation effects were developed considering the difference among stages postaccident (early, middle, later and long-term), and the differences between surrounding and remote areas and among stages postaccident (early, middle, later and long-term), respectively.

Radiation monitoring on land – unexpected effects on means of transportation and communication

Recommendation 1: Alternative means or cooperative system for land monitoring should be previously prepared assuming that the Off-site Center fails to function, the monitoring car is unable to be utilized or aircraft monitoring cannot be carried out as intended, and so forth.

Issue 1: Radiation monitoring on land could not proceed following the previously determined emergency preparedness plan owing to unexpected effects due to road damage, widespread power failure, fuel shortages in monitoring cars, damage to communications networks, and delay in the preparation of helicopters.

Radiation monitoring on land – monitoring posts washed away and communication lines severed

Recommendation 2: Monitoring posts should be upgraded so as to ensure high tolerance to earthquakes and tsunami.

Issue 2: Four of the 24 monitoring posts established by Fukushima Prefecture were washed away by the tsunami and another 19 were unable to transmit data owing to severed communication lines, which resulted in 23 monitoring posts being inoperable.

Tap water monitoring – communication method with public

Recommendation 3: Communication methods should be prepared to inform the public of a restriction period for the intake of drinking water (tap water, river water and well water, etc.) indispensable to keep our lives and the meaning of the regulatory value.

Issue 3: After notification on 23 March 2011 to refrain from providing tap water to infants in the 23 wards of Tokyo and the Tama area, the radioactivity concentration in tap water on 24 March decreased to below the regulation value. For this reason, it was announced that tap water may be used without any concern, including for infants. However, since mineral water could not be obtained in many areas, there were actually severe cases whereby people ultimately had to decide for themselves whether to drink tap water including radioactive materials or to refrain from drinking water and whether or not to continue breast feeding owing to concern of transferring radioactive materials from mother to infant. [the first JHPS recommendations]

Shipping restrictions and monitoring of agricultural and livestock products – expansion of contamination due to food chain

Recommendation 4: Methods to predict and restrict the expansion of contamination due to the food chain should be prepared for various agricultural and livestock products in response to the characteristics of the accident.

Issue 4: The Notice on Farming Management was not communicated to grain farmers, who produce rice straw. Furthermore, the information and guidance provided to cattle farmers were inadequate and it was discovered that cattle farmers had fed their cattle rice straw that had been stored outdoors and was most likely contaminated with radioactive material. This led to the detection of radioactive cesium exceeding the temporary regulation value in beef.

Shipping restrictions and monitoring of agricultural and livestock products – measurement method for livestock products

Recommendation 5: Methods to measure radioactivity in livestock products in emergency situations should be standardized in collaboration with expert committees and associated societies while verifying their technological validity by comparison with previous findings and conventional technologies. [**the first JHPS recommendations**]

Issue 5: Beef fed by contaminated rice straw could not be identified by inspection after slaughter.

Food monitoring – regional variations

Recommendation 6-1: Methods to measure radioactivity in foods in emergency situations should be standardized in collaboration with expert committees and associated societies while verifying their technological validity by comparison with previous findings and conventional technologies. [**the first JHPS recommendations**]

Recommendation 6-2: A cooperative system that will enable us to temporarily lend equipment for measuring radioactivity in foods should be developed after nationwide investigation of the availability of such equipment.

Issue 6: Food monitoring was left to the test plans of the prefectures, so the level of the monitoring varied depending on the prefecture. The monitoring equipment and other infrastructure in the various prefectures were insufficient at the early stage after the disaster. Moreover, there were also local governments that were unenthusiastic about performing monitoring because of their concerns about the harm to their reputation, so the level of monitoring varied depending on the local government.

Monitoring of forests and subsoils of rivers and lakes – lack of understanding of the necessity

Recommendation 7: Monitoring methods should be prepared taking into consideration the behavior and transition of radioactivity in forests and subsoils of rivers and lakes.

Issue 7: The necessity of monitoring forests and subsoils of rivers and lakes was not sufficiently understood.

Monitoring of seawater, subsoils of ocean, and sea products – lack of understanding of the necessity

Recommendation 8: Coastal sea area monitoring methods should be prepared taking into consideration the behavior and transition of radioactivity in sea water, subsoils of the ocean and sea products.

Issue 8: Since the necessity of sea area monitoring was not fully understood, the monitoring area was limited to the region within 30km from Fukushima Dai-ichi NPS at the early stage after the accident. Ocean currents formed around this local area were not considered in the monitoring design, which led to missing knowledge on the dynamics of the transition of radioactive materials from the source.

Monitoring of seawater, subsoils of ocean, and sea products – lack of prediction tools

Recommendation 9-1: Methods to predict and restrict the expansion of contamination due to the food chain should be prepared for various sea products in response to the characteristics of the accident.

Recommendation 9-2: A technique for simulating the transition of radioactivity in the ocean should be prepared as a nuclear emergency preparedness measure.

Issue 9: Since the seawater off Fukushima Prefecture travels down to the southern region of the Fukushima Dai-ichi NPS along the coast after the "Oyashio" current meets the "Kuroshio" current, radioactive materials in seawater traveled down to off the coast of Ibaraki Prefecture in the area south of the Fukushima Dai-ichi NPS, which led to the situation that radioactive materials temporarily accumulated in sand eels, forcing fishermen in Ibaraki Prefecture to refrain from fishing. In addition, radioactive materials also accumulated in bottom-dwelling coastal fishes (e.g., flat fish, flounder, etc.). The timing of the accumulation of radioactive materials in medium-sized fish owing to the food chain could not be predicted since the monitoring target at the early stage postaccident was not ocean subsoils but seawater.

System for Prediction of Environmental Emergency Dose Information (SPEEDI) – underutilization of prediction results

Recommendation 10-1: The calculation results obtained from SPEEDI should be promptly disclosed together with their uncertainty in a clearly understandable form so that municipalities and evacuees can actively use the data. [**the first JHPS recommendations**]

Recommendation 10-2: Usage of SPEEDI in the case that the Emergency Response Support System (ERSS) is unable to be used and a detailed plan for the evacuation of residents in the case that SPEEDI fails to be utilized should be clarified under the framework of nuclear emergency preparedness.

Recommendation 10-3: When the entire range within concentric circles is established as an evacuation area owing to the fast unfolding of events in the present accident, methods to predict areas scarcely affected by the diffusion of radioactive materials and to speedily inform the relevant parties of the predicted information should be determined in combination with monitoring information to continue disaster management, such as life saving activities in evacuation areas, as long as possible.

Issue 10-1: Since the external power supply was lost following the earthquake and the Government's dedicated line for sending data became unavailable, the release of source information from the Emergency Response Support System (ERSS) on which SPEEDI calculations are based was not carried out. For this reason, the Nuclear Safety Technology Center provided the predicted results of their unit release rate calculation based on "the Environmental Radiation Monitoring Guidelines", to the Ministry of Education, Culture, Sports, Science and Technology (MEXT), the Emergency Response Center (ERC), the Nuclear Safety Commission (NSC), the Off-site Center, the Fukushima Prefectural Office, and the Japan Atomic Energy Agency (JAEA) in response to the directive from MEXT on 11 March 2011. However, these predicted results were neither utilized to discuss practical evacuation measures nor disclosed to the public, since the calculations based on an assumed unit release rate did not show any actual radiation dose levels. [the first JHPS recommendations]

Issue 10-2: On the night of 12 March, NSC made one request for a SPEEDI calculation to the Nuclear Safety Technology Center. The NSC received the calculation results and shared them with its members, members of its technical advisory body in an emergency, and some staff members of the NSC Secretariat. The NSC, however, believed that the calculation results should only be utilized for internal discussion. As a result, the calculation results were not shared with any other organizations.

Issue 10-3: Meanwhile between 11 and 15 March, the Nuclear and Industrial Safety Agency (NISA) conducted SPEEDI calculations by entering various assumptions of release source information in order to grasp the dispersion trend of radioactive materials. The obtained predicted results were shared with various functional teams within the MEXT-ERC. A few results were provided to the Prime Minister's Office and the Off-site Center. However, NISA sent the Prime Minister's Office the SPEEDI predictions with an accompanying message that NISA believed the SPEEDI predictions to be of low reliability because the calculations were based on assumed release source information. Cabinet Secretariat staff treated them as reference information and did not report them to the Prime Minister.

Simulation system on the diffusion of radioactive materials in the ocean – lack of prediction tools in the emergency preparedness system

Recommendation 11-1: Methods to utilize simulation results of the diffusion of radioactive materials in the ocean should be determined under the framework of nuclear emergency preparedness.

Recommendation 11-2: The calculation results obtained from the simulation system for diffusion in the ocean should be promptly disclosed together with their uncertainty in a clearly understandable form so that municipalities and evacuees can actively use the data. [**the first JHPS recommendations**]

Recommendation 11-3: A system to estimate the medium- to long-term effects of ocean contamination on sea products should be established.

Issue 11: No simulation system for the diffusion of radioactive materials in the ocean has been established in the nuclear emergency preparedness system, since people do not live on sea area, unlike on land. [the first JHPS recommendations]

Evacuation of residents and its criterion - extension of order to stay indoors

Recommendation 12: The adoption of both short-term and long-term criteria in a stepwise manner should be examined by considering the balance between emergency measures that may be effective both temporarily and over the long term, and the maintenance of infrastructure required to ensure the secure everyday life of the general public. [**the first JHPS recommendations**]

Issue 12: The results of radiation monitoring and SPEEDI retrospective estimation showed there were areas with high radiation doses even more than 20km from the Fukushima Dai-ichi NPS. The distribution of essential items was disrupted in stay-indoors evacuation zones and it was difficult for residents to conduct their daily lives. In the Nuclear Emergency Guidelines, the enforcement of a stay-indoors evacuation for a long period of time was not assumed. [the first JHPS recommendations]

Evacuation of residents and its criterion – instruction of deliberate evacuation

Recommendation 13: Since the deliberate evacuation zones, which were proposed after the disaster for the first time, were areas in which evacuation was recommended on the basis of the annual individual dose rather than on the need for emergency evacuation, thorough discussions should be held with municipalities to determine suitable evacuation zones and the period of evacuation. [**the first JHPS recommendations**]

Issue 13: On 11 April 2013, Chief Cabinet Secretary Edano announced a fundamental concept of how deliberate evacuation zones should be established. Subsequently, the government issued early advice to the affected municipalities and then, on 22 April, the Nuclear Emergency Response Headquarters (NERHQ) established deliberate evacuation zones and provided those municipalities with a directive to inform residents in the zones to be prepared to

evacuate after a period of approximately one month. [the first JHPS recommendations]

Evacuation of residents and its criterion – communication of evacuation instruction

Recommendation 14: Measures, such as an order of evacuation, in the case that the Off-site Center, where the Local Nuclear Emergency Response Headquarters (NERHQ) is located, fails to function should be previously established including, for instance, where the Local Headquarters should be replaced to.

Issue 14: The Emergency Preparedness Guide prescribes that the head of the local headquarters shall communicate an evacuation order to each municipality, including cities, towns, and villages. Most of the municipalities actually learned of the evacuation instructions through the mass media including TV. Some of them learned through verbal announcements from police vehicles, including police patrol cars.

Evacuation of residents and its criterion – evacuation beyond a designated zone for emergency preparedness

Recommendation 15-1: Emergency planning zones (EPZs) that are designated for emergency preparedness within a radius of 8-10 km from nuclear power plants and related disaster management measures should be reviewed through full discussions with municipalities with consideration of the post disaster spread of contamination to a large area, as observed in this disaster. [**the first JHPS recommendations**]

Recommendation 15-2: The evacuation route and the destination should be previously identified together with a method for the supply of food and drinks on the basis of the nuclear accident size considered.

Issue 15: Each of the municipalities located within a 10km radius (equivalent to the Emergency Planning Zone, or EPZ) of a power plant is expected to possess regional disaster prevention plans and evacuation plans. Each municipality is, as a rule, primarily responsible for formulating evacuation plans and implementing these plans, but in the event of evacuation over a wider area (across municipalities), Fukushima Prefecture bears the responsibility of formulating an evacuation plan. However, in reality, the only evacuation cases in which Fukushima Prefecture took the lead in coordinating shelters across municipalities were for Futaba Town and Okuma Town, when an evacuation instruction was issued for areas lying within a 10km radius.

Evacuation of residents and its criterion – evacuation of socially vulnerable individuals

Recommendation 16: For the evacuation of socially vulnerable individuals such as people in medical institutions, homes for the aged and welfare facilities, and developmentally disabled individuals, an emergency evacuation strategy including methods of communication by satellite phone should be provided in the nuclear emergency preparedness plan that is independent of the endeavor of the individuals or the facilities.

Issue 16: People who had difficulty evacuating, such as hospitalized patients, were left behind in the area within a radius of 20km from the nuclear plant, which had been designated as an evacuation zone. In the situation where communication was limited and sufficient information could not be obtained, the evacuation of hospitalized patients was extremely difficult, resulting in many cases of aggravated medical conditions or death.

Radiological protection criteria – criteria for administration of stable iodide – confusion regarding administration criteria

Recommendation 17-1: The emergency measures of evacuation and stay indoors, distribution of stable iodide, and regulation of the ingestion of foods and drinks should be

comprehensively examined to ensure consistency in their principles. [**the first JHPS recommendations**]

Recommendation 17-2: The concept of criteria for administration of stable iodine should be clarified, taking into consideration that there may only be insufficient radiation monitoring data available in an emergency without SPEEDI information.

Issue 17: Local governments were able to obtain a sufficient amount of stable iodine tablets, but instructions to take the stable iodine tablets were not given because there was no information on predicted radiation dose by SPEEDI. On the other hand, new criteria for the administration of stable iodine were provided by the NSC on the basis of a screening level. This advice, however, did not reach Fukushima Prefecture and the cities, towns, and villages concerned. There was no opportunity to take iodine tablets except for some residents who were given instructions at a local government's own discretion. [the first JHPS recommendations]

Radiological protection criteria – screening level – validity of the level

Recommendation 18-1: The validity of the screening criteria for decontamination in an emergency in terms of their effectiveness for radiation protection should be verified in accordance with the principles of other emergency measures by considering problems that may arise in relation to the radiation measurement. [**the first JHPS recommendations**]

Recommendation 18-2: According to the stage postaccident (early, middle, later and long-term), when the environmental contamination level reduces, a lower value of the screening level for decontamination should be selected in a stepwise manner in accordance with the reduction of the surrounding environmental contamination level. Also, the concrete process for selecting the screening level should be previously determined.

Recommendation 18-3: Since there are many valuable items in broadly contaminated areas, which could be recycled or reused in normal circumstances, the screening level for recycling should be set in addition to that for decontamination. Moreover, in the case that objects for reuse or recycling are restricted, the process used for setting the screening level should be previously determined because the screening level in the restricted areas can be relaxed in accordance with environmental contamination level.

Issue 18: The screening level was raised in accordance with the present situation using different levels from those that had been previously established. [the first JHPS recommendations]

Radiological protection criteria – criteria for contamination of soil (schoolyards and educational facilities, and bathing areas, utilization of crushed stones, and disposal of disaster waste and sewage sludge) – consistency of concepts for derivation of criteria

Recommendation 19-1: Reference levels should be determined on the basis of the overall policy by considering the radiation sensitivity of children and the balance among reference levels, and, if necessary, stepwise reference levels should be adopted. Also, with the cooperation of experts who can support residents' viewpoints, the active cooperation and understanding of stakeholders including residents should be obtained to determine the reference levels, which should not be described as permissible levels because they do not indicate a threshold between safe and hazardous levels. [**the first JHPS recommendations**]

Recommendation 19-2: The reference levels for radioactive waste should be set to below those for broad contamination in the overall plan of environmental restoration with the active cooperation and understanding of stakeholders including residents and the cooperation of experts who can support residents' viewpoints. Also, radioactive waste should be managed so that the assessed individual dose becomes lower than the determined reference levels and

disposed of in a planned manner so that the assessed individual dose satisfies a target dose of 1 mSv/y or lower. [**the first JHPS recommendations**]

Issue 19: It has become difficult to explain the consistency among all the criteria since each criterion was determined using a different concept. [the first JHPS recommendations]

Radiological protection criteria – criteria for food and beverages - comprehensiveness of food categories

Recommendation 20: Categories of foods and their restriction values should be reviewed by considering statistical results on their annual amount of ingestion and by monitoring of radiation levels in foods and following an optimization principle in which social and economic factors are taken into account. [**the first JHPS recommendations**]

Issue 20: Since in the provisional regulatory values (by 31 March 2012) for radioactive materials contained in foods, the restriction values for radioactive iodine in fish and foods not to consumed directly, e.g., tea leaves, were not specified, much confusion occurred. [the first JHPS recommendations]

Radiological protection criteria – criteria for food and beverages – universal use for various types of accident

Recommendation 21-1: The emergency measures of evacuation and stay indoors, distribution of stable iodide, and regulation of the ingestion of foods and drinks should be comprehensively examined to ensure consistency in their principles. [**the first JHPS recommendations**]

Recommendation 21-2: The adoption of both short-term and long-term criteria in a stepwise manner should be examined by considering the balance between emergency measures that may be effective both temporarily and over the long term and the maintenance of infrastructure required to ensure the secure everyday life of the general public. [**the first JHPS recommendations**]

Issue 21: Since the new regulatory value for food and beverages enforced on 1 April 2012 was derived for only radioactive cesium on the basis of 1mSy/y as an internal exposure dose and can be applied to the current situation after the present accident, it cannot be universally used as a criterion for emergency preparedness where various types of accident should be considerd. [the first JHPS recommendations]

Radiological protection criteria – criteria for food and beverages – approach to dose criteria

Recommendation 22: The individual dose criteria used as references to derive the restriction values of radioactive materials in foods should be determined after full discussion with stakeholders associated with the production, distribution, and consumption of foods. [**the first JHPS recommendations**]

Issue 22: In the derivation of the new regulatory value for food and beverages enforced on 1 April 2012, 1mSv was adopted as a dose criterion, strictly shifting from 5mSv; nevertheless, the estimated dose due to intake of contaminated foods was sufficiently low and was determined without full discussion with stakeholders associated with the production, distribution, and consumption of foods. [the first JHPS recommendations]

Radiological protection criteria – protective criteria for temporary entry into restricted zones - balance among other risks

Recommendation 23: Flexible systems that will allow people of different ages including the elderly to temporarily enter restricted zones for various purposes should be developed by considering the balance of radiation protection measures with other risks and inconvenience,

rather than uniformly imposing the wearing of a protective suit and limiting the entry time. [**the first JHPS recommendations**]

Issue 23: Irrespective of the ambient dose level in the residence, the maximum time spent at home during temporary entry was limited to 2 h, and the total time taken for the round trip from the relay point to each home was limited to 5 h. [the first JHPS recommendations]

Radiation exposure of residents – estimation of thyroid equivalent dose of radioactive iodine by simple measurement

Recommendation 26-1: The thyroid equivalent dose for the internal exposure to radioactive iodine should be calculated on the basis of the results of simulating the atmospheric diffusion of the radioactive plume using SPEEDI, food inspections, and surveys on residents' behavior. Also, the calculation results along with their uncertainty should be disclosed. [**the first JHPS recommendations**]

Recommendation 26-2: The standardization of methods of evaluating the thyroid equivalent dose of radioactive iodine by simple measurement should be examined in collaboration with expert committees and associated societies while verifying their technological validity by comparison with previous findings and conventional technologies. [**the first JHPS recommendations**]

Recommendation 26-3: The thyroid equivalent dose assessment carried out by other researchers and methods to estimate the thyroid equivalent dose of 1,080 children using simple measurements should be invetigated and the results should be reflected in the discussion of the uncertainty of the thyroid equivalent dose of residents.

Recommendation 26-4: Emergency environmental monitoring guidelines should be verified including dose assessment postaccident. A system that can be operated with good understanding of the guidelines should be established developing human resources. Moreover, a mechanism to enable the system to be maintained over a long time should also be established.

Issue 26: Screening tests for thyroid gland exposure levels on 1,080 infants and children were carried out in Iwaki City, Kawamata-machi, and Iitate-mura from 26 March to 30 March 2011; however, this involved low-precision tests and no further tests of the thyroid gland exposure levels of the children were carried out. [the first JHPS recommendations]

Radiation exposure of residents – internal dose assessment using whole body counter (WBC) – investigation system

Recommendation 27-1: A cooperative system that enables the temporary lending of WBCs and dispatch staff for measurements to the affected area should be developed after nationwide investigation of the availability of such equipment and training of the staff. Also, a system that enables the investigation of internal exposure using WBCs should be established, led by the national or prefectural government immediately after an accident.

Recommendation 27-2: It is necessary to consider methods of maintaining the large number of WBCs after the accident and to make a Q&A booklet or manual instructions to enhance the understanding of how the monitoring results of WBCs should be explained to the public.

Issue 27: As part of the Fukushima Prefecture Health Management Survey started in June 2011, individual doses for external exposure were investigated as the External Dose Estimation based on the behavior records in the Basic Survey. However, investigation of the dose for internal exposure using the WBC was not carried out in the Basic Survey. For this reason, the WBC measurement results are individually kept in each municipality or hospital since these data are a form of personal information that is unavailable for use for other objectives without permission. The WBC measurement for internal exposure was not addressed in the

nuclear emergency preparedness plan, which was a main cause of the delay in conducting the WBC measurement.

Radiation exposure of residents – internal dose assessment using whole body counter (WBC) – measurement method

Recommendation 28: The standardization of radiation-related emergency methods of evaluating the internal dose using WBCs and the bioassay method should be examined in collaboration with expert committees and associated societies while verifying their technological validity by comparison with previous findings and conventional technologies. [**the first JHPS recommendations**]

Issue 28: Since individual dose assessment for internal exposure using the WBC highly collected the needs of residents, the WBCs were individually set up by municipalities, hospitals, and nongovernmental organizations, in addition to direct management by the Fukushima prefectural government. Therefore, the dose assessment was carried out by nonunified methods without standardization. [the first JHPS recommendations] Although it is important, when using a great number of WBCs as a monitoring tool, to ensure the traceability from the viewpoint of maintaining the reliability of the measurements, there are no standards for WBCs. Also, there are no manuals to effectively explain the WBC monitoring results to the public.

Radiation exposure of residents – external dose assessment using personal dosimeters

Recommendation 29: A cooperative system that enables the temporary lending of personal dosimeters to the affected area should be developed. Also, a system that enables the investigation of external exposure using personal dosimeters should be established, led by the national or prefectural government immediately after an accident.

Issue 29: Since dose assessment was carried out by each municipality by lending personal dosimeters in response to the needs of residents, individual dose data for external exposure are kept in the respective municipality because these data are a form of personal information that is unavailable for use for other objectives without permission.

Radiation exposure of residents – external dose estimation on the basis of behavior survey

Recommendation 30: Knowledge and skill regarding the external dose assessment system developed in the implementation of the the Basic Survey of the Fukushima Prefecture Health Management Survey (the External Dose Estimation), the format of the inquiry form and relevant activities for improving the recovery ratio should be shared. Also, a system that enables us the survey to be started immediately after an accident should be established.

Issue 30: As part of the Fukushima Prefecture Health Management Survey started in June 2011, the individual dose for external exposure was investigated as the External Dose Estimation, using the behavior records obtained via sets of inquiry forms in the Basic Survey. However, the recovery ratio of inquiry forms was only 18% in December 2011. (As of 31 January 2013, the recovery ratio for the whole area of the prefecture was 23.2% and that for the preceding investigation area, Yamakiya district of Kawamata Town, Namie Town, and Iitate Village was 56.7%)

Communication to the public – spreading understanding of radiation effects

Recommendation 35-1: Activities to improve nationwide knowledge of the long-term effects of radiation should be started, taking into consideration not only areas relevant to the nuclear emergency and education in schools but also all generations of Japanese people. Moreover, by considering the risks and benefits of not only radiation but also all other applications of science and technology, opportunities should be provided to discuss and understand concepts

without taking alternative ways to whether they are safe or dangerous.

Recommendation 35-2: Human resources such as spokespersons for radiation protection who can provide easy-to-understand explanations should be developed as part of a long-term strategy. [**the first JHPS recommendations**] Also, the ability to explain radiation effects in a face-to-face manner in an emergency should be ensured by developing the communication skills of people in municipal government to explain the risk posed by radiation to local residents.

Recommendation 35-3: Effective methods for communication with the public, for instance, small-size dialogue meetings in the surrounding area and large-size dialogue meetings in remote areas using large facilities in a major town, should be established taking into consideration that there will be a large number of people to communicate with in remote areas where the environmental contamination level is relatively low and the size of the area is large, compared with the surrounding area near the accident site where the environmental contamination level is relatively high.

Recommendation 35-4: Systems to dispatch risk commnunication experts who fully understand the newest data and changes in the values of criteria with time should be prepared taking into consideration that in the early stage postaccident, there were a lot of simple questions regarding radiation and its effects, and the themes of the questions changed in various ways with the passing of the stages postaccident (early, middle, later and long-term), such as suspicion about governmental announcements, the implications of various standards or measurement results, greater understanding of measured results and suggestions for minimizing risk in daily life. In addition, systems to share both successful and unsuccessful experiences should be prepared.

Recommendation 35-5: As an appropriate public relations measure, unclear expressions such as those in which the intended meaning is unclear should be avoided. In particular, for the explanations of radiation exposure, communication systems supported by experts should be established together with consistent explanations of low-dose radiation effects in an easy-to-understand manner.

Issue 35: The Government often explained, "It does not have immediate effects on health", concerning the influence of radiation on the human body. This expression may be interpreted by some people as "it is unnecessary to be anxious about the impact of radiation on human health," while it may be interpreted by other people as "it does not immediately affect human health, however, some effects on human health will appear in the longer term." However, it was not necessarily clear what the intended meaning of the expression was, and there was no detailed explanation. Moreover, anxiety regarding unknown nuclear disasters and dissatisfaction about the explanation from the government were broadly shared. One of the reasons for this is that we have neglected to endeavor to improve public understanding of radiation and have never trained radiological protection experts for communication in the municipal government in the nuclear emergency preparedness plan.

Communication to the public – comprehensibility of radiological protection system

Recommendation 36: Discussions should be started towards the reestablishment of simple systems for protecting the public from radiation exposure, which will require high accountability to the public, both under normal conditions and in emergencies (including emergency and existing exposure situations), reconsidering the concept of radiation risk.. [**the first JHPS recommendations**]

Issue 36: Residents who had to live in an environment contaminated by radioactive material after the accident sought information about the level of radioactivity that would serve as a basis

for making decisions. Mothers, in particular, sought accurate information about the extent of contamination in the food and beverages they were giving their children, and about the radiation dose from the environment and its potential effects on their health. However, the information that was made available to the residents was not satisfactory. [the first JHPS recommendations]

Communication to the public – utilization of mass media

Recommendation 37: A system that enables the timely provision of information obtained by accurately collecting information required by people through the bidirectional interactive exchanges of information using social media in an emergency and utilizing both social media and mass media should be established.

Issue 37: The government rapidly responded to online communication by consolidating the relevant information onto its homepage and opening an official twitter account of the Cabinet. However, it used only one way communication such as mass media and could not provide appropriate timely information or gain the public's confidence, since the information was not obtained through bidirectional exchanges utilizing the characteristics of social media.

Communication to the public – response to foreign residents and overseas countries

Recommendation 38: Taking into consideration the effects on neighboring countries in an emergency and ensuring the safety of foreign residents, a system that enables the timely provision of information to foreign countries and residents should be developed while clarifying the decision-making process for the order to evacuate and discharge to the ocean. Moreover, the authorized discharge of water contaminated with low-level radioactive materials to the ocean in a controlled situation should be decided with sufficient involvement and understanding of stakeholders concerned with the fishing industry, with the cooperation of experts who can support the viewpoint of the industry.

Issue 38-1: Although the discharge of the less contaminated water into the sea conducted on 4 April 2011 did not fall within the scope requiring notification prescribed in the United Nations Convention on the Law of the Sea, the notification stating that the discharge would begin was sent the day of discharge after it had already started and countries around Japan were not informed of the discharge in advance.

Issue 38-2: The U.S. Nuclear Regulatory Commission (NRC) had been seeking detailed information regarding the status of the Fukushima Dai-ichi NPS from the Japanese government since 12 March 2011. However, the Japanese government was incapable of providing such information to the U.S. in a manner satisfactory to the U.S. side, because Japanese government had not been able to acquire sufficient information on the nuclear power plant itself and officials of NISA and other government staff familiar with the situation at the nuclear plant were preoccupied with their work of dealing with the plant's situation. For this reason, the NRC decided to issue evacuation advice as a safety measure, and on 17 March (Japan time) advised U.S. citizens in Japan to evacuate to outside of a 50-mile (about 80km) radius of the Fukushima Dai-ichi NPS. This led to confusion because this radius for evacuation was significantly larger than the 20km radius of the Japanese evacuation area.

Nuclear emergency preparedness system – preparedness for complex disasters

Recommendation 39-1: Nuclear emergency preparedness should be reconsidered considering the voices of relevant municipalities including countermeasures prepared for an accident scenario where events unfold quickly and a complex disaster involving earthquakes

and tsunamis occurring simultaneously with a nuclear disaster.

Recommendation 39-2: Expert groups who can respond to unanticipated accidental events should be developed by daily training incorporating up-to-date technical knowledge.

Issue 39: Serious confusion occurred in the relevant organization owing to insufficient preparedness for an accident scenario where events unfold quickly and for facing a complex disaster involving earthquakes and tsunamis occurring simultaneously with a nuclear disaster.

Nuclear emergency preparedness system – opportunity of revision of nuclear emergency preparedness for complex disasters (earthquake, tsunami, and nuclear accident)

Recommendation 40: Nuclear emergency preparedness should involve a system that is regularly and rapidly updated according to new knowledge, technology and suggestions and so on. Also, natural features should be established to prevent the inflexibility and obsolescence of countermeasures.

Issue 40: Although problems of emergency preparedness assuming the possible occurrence of a nuclear emergency coupled with a complex disaster were pointed out, no measures were taken against them.

3.2 Recommendation on protection of workers

In this section, recommendations are described in response to issues highlighted in the previous chapter from the viewpoint of radiological protection for workers. In the drafting the recommendations, comments listed at JHPS symposia as described in section **2.3** were incorporated. On the basis of the results obtained in the previous chapter, recommendations regarding **Issue 18**: Radiological protection criteria – screening level – validity of the level were developed considering the difference among stages postaccident (early, middle, later and long-term). In addition, recommendations regarding **Issue 31-32**: Radiation exposure of plant recovery workers were developed considering those for rescue/decontamination workers.

Radiological protection criteria – screening level – validity of the level

Recommendation 18-1: The validity of the screening criteria for decontamination in an emergency in terms of their effectiveness for radiation protection should be verified in accordance with the principles of other emergency measures by considering problems that may arise in relation to the radiation measurement. [**the first JHPS recommendations**]

Issue 18: The screening level was raised in accordance with the present situation using different levels from those that had been previously established. [the first JHPS recommendations]

Radiological protection criteria – dose criteria for emergency work – dose limit taking life-saving work into account

Recommendation 24: New dose limits for emergency workers to take into account the need for emergency medical care should be examined while clarifying the decision-making process and considering the fact that the adopted dose limit for emergency workers is 250 mSv, which is lower than the internationally recommended value, and that the current dose limit for radiation workers under normal situations is determined on the basis of a lifetime individual dose of 1,000 mSv. [**the first JHPS recommendations**]

Issue 24: In the second interim report on the incorporation of the 2007 Recommendations of the ICRP into domestic systems, the Basic Committee of the Radiation Council proposed to match the dose limits to internationally recommended values, taking into consideration that opportunities to participate in international activities were increasing for domestic workers, because the current restriction criteria in Japan (dose limit, 100 mSv) interfered with emergency medical care and other essential operations. On the other hand, in response to the present accident, 250mSv was adopted as a dose limit for emergency workers. This value is lower than the internationally approved principles and the recommended value of the 2007 Recommendations of ICRP (emergency medical care, no restriction; other emergency rescue operations, 1,000 or 500 mSv; other rescue operations, 100 mSv). [the first JHPS recommendations]

Radiological protection criteria – dose criteria for emergency work – treatment of individual doses received in an emergency situation

Recommendation 25: The individual dose in an emergency should be controlled independently of the compliance with the dose limits for radiation workers under normal conditions (50 mSv per year and 100 mSv over five years) to control radiation exposure. [**the first JHPS recommendations**]

Issue 25: In the second interim report on the incorporation of the 2007 Recommendations of the ICRP into domestic systems, it was indicated that emergency work doses will be treated

separately from normal work doses. However, the Ministry of Health, Labor and Welfare (MHLW) issued an official notice stating that when managing dose limits during normal work, if a worker has a history of engaging in emergency work, the doses received during such work should be included and the limit of 100mSv/5 years should be applied. [the first JHPS recommendations]

Radiation exposure of plant recovery workers – network for urgently borrowing alarm pocket dosimeters (APDs)

Recommendation 31: An emergency procedure for borrowing APDs, whole body counters (WBCs) and protective tools for internal exposure from other nuclear power stations should be developed for plant recovery workers. Also, systems to ensure the availability of sufficient numbers of personal dosimeters and protective tools for internal exposure should be established for rescue or decontamination workers.

Issue 31: Although many APDs were provided as aid supplies from other NPSs, these APDs were simply stored and remained unused owing to a lack of communication. There were not enough APDs and by 15 March, not every worker was able to wear an APD, which led to the decision that only the leaders of each operational group would wear APDs on behalf of the entire group.

Radiation exposure of plant recovery workers – control of internal exposure in an emergency

Recommendation 32: The performances and the methods of using protective tools for internal exposure, appropriate methods for eating, drinking and excretion in the case of a long-term emergency situation, protective measures to prevent the reduction of airtightness of seismic isolation buildings used in an emergency and a method for the administration of stable iodine should be trained and practiced in a practical manner for both the plant recovery and rescue/decontamination workers.

Issue 32-1: The individual doses of 6 workes exceeded 250mSv, which was the dose limit for emergency workers temporarily prescribed after the accident.

Issue 32-2: The doses of two female employees significantly exceeded the 5mSv three-month upper limit for female radiation workers, although they took appropriate radiological protection measures such as wearing full-face masks with charcoal filters whilst working in the field, since the double-entry doors to the Seismic Isolation Building were not airtight and the doors to the Seismic Isolation Building were bent and twisted by the hydrogen explosions in Units 1 and 3.

Issue 32-3: 178 workers showed thyroid gland equivalent doses of over 100mSv, and 25 workers under the age of 40 did not take iodine tablets.

Radiation exposure of plant recovery workers – control of localized exposure in an emergency

Recommendation 33: Protective measures against the localized exposure of radiation should be previously trained and practiced in a practical manner for plant recovery workers, assuming a sudden change in the working environment such as an explosion and leakage of contaminated water in an emergency.

Issue 33: On 24 March, two of three workers who were installing electric cables under the surface of the basement floor of the Unit 3 turbine building were exposed to high radiation doses while working immersed in contaminated water, because they were wearing low quarter shoes. Although it was made clear, after getting cleaned up and having a checkup and getting tested to measure internal radiation doses, that neither worker suffered radiation heat burns on their feet, there had been a possibility of suffering from radiation heat burns due to

continuous localized exposure.

Radiation exposure of plant recovery workers – managing access to and from a controlled area in an emergency

Recommendation 34: Practical methods regarding the management of individual doses and education before registration as a radiation worker in the case of an emergency situation postaccident, where it is difficult to precisely implement protective measures for radiation control, should be established for the plant recovery workers.

Issue 34-1: After the nuclear accident, access to and from the controlled area of the management system was initially impossible for calculating the radiation dose of individual radiation workers. It was then decided to manually calculate the radiation dose of individual radiation workers using APDs. (On 14 April, five simplified instruments were installed in the Seismic Isolation Building for gaining access to and from the controlled area management system. At the same time, a radiation work permit with bar code patterns was introduced so that the names and radiation doses of individual workers could be automatically recorded).

Issue 34-2: From the date of the nuclear accident to 10 May, radiation workers were allowed to carry out their duties after receiving a brief 30-minute explanation about how to protect themselves from radiation and how to wear protective equipment.

4. Final remarks

The accident at Fukushima Daiichi Nuclear Power Plant was extremely large-scaled disaster comparable to Chernobyl Accident. After a criticality accident in JCO uranium processing plant in Tokai village occurred in 1999, the Act on Special Measures Concerning Nuclear Emergency Preparedness was legislated in the same year as an act on special measures of the Disaster Countermeasures Basic Act and the Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors. This act was established to protect lives, bodies and property of Japanese citizens and prescribed responsibilities of notification by nuclear operator, collabolation between government and local public body, and establishment of nuclear emergency response headquarters in an emergency, etc. As new measures in those days, placement of senior specialist for nuclear emergency preparedness, designation of the Off-site Center and enforcement of the training for emergency preparedness were prescribed. However, after the Fukushima Daiichi nuclear disaster following the Great East Japan Earthquake, relevant laws including the Act on Special Measures Concerning Nuclear Emergency Preparedness, guidances, plans and operational manuals could not responded to unanticipated situations, which disclosed their defectiveness. The Act on Special Measures Concerning Nuclear Emergency Preparedness was revised on September in 2012.

To gain lessons learned from the Fukushima nuclear disaster, JHPS has reviewed issues associated with radiological protection after Fukushima Daiichi Nuclear Power Plant Disaster through JHPS special symposia, Q&A communication and so on. After the accomplishment of the first set of JHPS recommendations, five investigative reports (Governmental Interim Report, Governmental Final Report, National Diet Report, Nongovernmental Report and TEPCO Report) were published, which clarified a lot of concrete facts in association with radiological protection. JHPS comprehensively reviewed these investigative reports, summarized voices collected in the JHPS symposia, verified how radiological protection measures after an accident should be operated, and elaborated a comprehensive report on the second set of recommendations including the first set of recommendations.

In chapter VI “Wrap-up and Recommendations” in the Governmental Final Report, it is recommended that “The government, nuclear operators, nuclear plant manufacturers, research institutions, academies, and all such stakeholders (relevant organizations) involved in nuclear power generation should take active roles in investigating the accident and in fact analyses, and continue, in their respective capacities, their comprehensive and thorough investigations of the remaining unresolved problems.” Moreover, in the JHPS special symposium, it was pointed out that follow-up after recommendations is important. JHPS considers that a committee for the follow-up after recommendations should be established and such an activity should be continued. In this sense, JHPS, including many radiological protection experts, would have a responsibility to continue involvement associated with radiological protection related to the Fukushima Daiichi nuclear disaster.

We hope that this second set of recommendations will be utilized by experts in the JHPS, residents in affected areas and relevant staff in the government, and discussed by international radiation protection experts in cooperation with overseas associated societies such as the Asian and Oceanic Association for Radiation Protection (AOARP), the International Radiation Protection Association (IRPA) and the Health Physics Society in the US.

Through above-mentioned activities, we believe that these recommendations will be of help in utilization as lessons learned from Fukushima Daiichi Nuclear Power Plant Disaster

and development of the scientific fields of health physics and radiological protection,

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Appendix I Voice record at Special Symposium of the Japan Health Physics Society on the second Fukushima project (25 May 2013)

The JHPS Special Symposium on the second Fukushima project was held at Koshiba Hall in Tokyo University on 25 May 2013. Three reserved speakers previously invited from JHPS members made their presentations regarding internal exposure monitoring, environmental monitoring and assessment, and risk commnucation. In accordance with these presantations, members on the floor raised their questions and comments. The voice recod is as follows:

Internal exposure monitoring

(Invited speaker)

- Internal exposures of 120,000 persons have been ever measured. The results indicate that individual doses of almost all persons were lower than 1 mSv.
- The number of the Whole Body Counter (WBC) in operation is 150 to cope with the current situation, which may not be precisely correct.
- Expert research group was established in the JHPS last year to discuss about recommendations on internal exposure monitoring for the residents and standardization of monitoring outside the body such as methods of measurements and estimation of internal exposure.
- The main issues in the discussions are domestic standardization of equipments for measuring radioactivity in the body, recommendations on the maintenance of the equipments, approach of internal dose assessment for residents and archive and explanation of the measurement results.
- The objective of the domestic standardization of equipments for measuring radioactivity in the body is to ensure a quality of the WBC operated in Japan. The standardization means to make a Japanese Industrial Standard (JIS) taking into consideration international standards. As for the WBC, IEC61582 will be refered.
- The main framework is to categorize the equipments in accordance with performance requirements and objective of usage. Specifically to say, it is categoraized into four types, such as WBCs with high performance in research institute and in-situ screening measurement using detector and shield in the accident.
- Criteria of the inspection items will be set at according to type of the category.
- These criteria should basically follow the JIS, whreas ambigous part still remains. For instance, it would be discussed what standard for phantom should be, because there is no description about the phantom in the IEC.
- It is planed that the standard will be established within two years, so it is in drafting so as to be in time for the first JIS meeting.
- There are a lot of WBCs, particurally in Fukushima prefecture, there are 56 WBCs. It should be noted to maintenance the accuracy of the WBCs. In National Institute of Radiological Science (NIRS), the maintenance of the accuracy is carried out by a contract with the Ministry of Environment (MOE). The 18 WBCs were completed last year.
- Ambient dose in air surrounding the equipment, detection efficiency, resolution and quantification of the standard phantom have been evaluated with sufficient accuracy.
- As a future issue and recommendation, it is important to ensure the traceability from a viewpoint of assurance of the reliability of the measurement. Standarization on the basis

of the activities in the JHPS expert research group is required since there is no relevant standard in Japan.

- There would be new issues during the discussion for the standardization. It is necessary to unify understandings among interested members about preparation of standard phantom for calibration, detection limit, spectrum analysis method and dose assessment method, etc. Moreover, standard manual for operating staff of the WBC is needed.
- As a problem of the resorce required for the monitoring of the internal exposure, it should be discussed who maintains a lot of WBCs and how they do so, in addition to development of the measurement staffs.
- It is necessary to fully explain the measurement results to the public and make a Q&A booklet including how they should do and manual assembly for WBC in cooperation with experts of risk communication.

Question & comments

Q (attendee): How did you collect the WBC measurement staffs in Fukushima prefecture and from where?

A (speaker): At first, WBC measurements for residents were started in the NIRS as the Fukushima Prefecture Health Management Survey. Subsequently, they were continued in the JAEA. In addition, to respond the requirements for measurement in the Fukushima prefecture, the WBCs were equipped in the municipal governments or hospitals and the measurement staffs were placed there.

Q (chairperson): Is it necessary to previously prepare measurements for internal exposure in the emergency preparedness? This is because main target of the WBC measurements was occupational exposure. To say about internal exposure in the nuclear emergency preparedness, it is only monitoring for thyroid. Were there any problems about it?

A (speaker): The most serious problem was delay of the WBC measurements due to various factors. Start of the measurements was three months after the earthquake. There are a lot of issues, for example, who shoud have a priority among the public to be measured earlier except for workers, children who are sensitive to radiation and family including children should be measured earlier with high priority and how we could accurately measure the members of the public who have various body sizes although workers had been main target of the measurements.

Environmental monitoring and its evaluation

(Invited speaker)

- I think it is necessary to review the initial environmental monitoring at early stage after the accident. We should seek issues such as monitoring for ocean. There were many things which could not be done well in the existing framework of the emergency preparedness. It is necessary to review them after deeply reviewing the monitoing results.
- We shoud consider whether the monitoring data were helpful, fully informed to the public, could be given to the staffs who needs them and correct or not.
- To say about whether the monitoring data were helpful or not, the data was valuable as fundamental information for judgment of start of the evacuation of the public though there were only data of ambient gamma dose rate in air just after the accident. However,

they were difficult to use for postaccident investigation of public exposure at early stage.

- The monitoring data were difficult to use except for gamma dose rate. We could not get information about concentration in air and ground surface density of radioactive nuclides just after the accident. These data can not estimate from the ambient dose rate in air. The monitoring data of noble gas or gaseous substances could not see immediately because sampling using charcoal filter is needed. Therefore, amount of intake due to inhalation could not be estimated easily. As a result, these data were difficult to be utilized for postaccident investigation of public exposure.
- Necessary data is not only gamma dose rate that is available for estimation of external exposure. The dose rate does not be used for estimation of the internal exposure. There is no data except for in the monitoring points. It would become necessary to investigate the individual dose of the public after the accident even if the monitoring is densely carried out. Especially concentration of radioactive nuclides in air could not be gained if there is no monitoring at that time, though surface density of radioactive nuclides could be measured later if they remain. As a result, it is difficult to estimate the external exposure in the non-monitoring points and the internal exposure due to inhalation. As for the internal exposure, postaccident investigation is possible by rapidly started WBC measurements, thyroid monitoring and bioassay measuments and so on. The concentration of radioactive nuclides in air could not be obtained if there is no monitoring at that time.
- Affected residents have their own lives after end of confusion postaccident. The life without resolution of concerns of radiation effects leads to reduction of the QOL. Was there necessity of environmental monitoring system including a scope of postaccident investigation of the public exposure? Gamma spectrum measuments shoud be previously prepared for the monitoring much more?
- To say about whether the monitoring data were efficiently informed to peoples who need and use them after measumements, there were various types of data opened throgh the internet. The data were copies of FAX, handwritten paper and PDF. The system and equipments for arranging the data so as to be easy to be utilized, for instance, to input necessary data into EXCEL files. The staffs could realize what data is needed for the analysis? The system and equipment for giving a significance of the analysis and the data and making a material for judgments of countermeasure were sufficiently supplied? The staff who decided final judgments understood what is needed for the judgment?
- Were there any people who needed the data in the staffs or persons who would go for rescue? The data was informed to “government” responsible for the systems, “non-govenment” requested or voluntarily activated, local community, medical and nursing staffs, and transport companies? Not only “government” and also “non-govenment” to utilize power of “non-govenment”. There is a need of not only numerical data but also suggestions on appropriate countermeasures for radiological protection and prevention of expansion of contamination. There is also a need of care after the accident, for example, brave actions may produce a concern after emotionally excited situation during the disaster.
- It is insufficient to only “accurately measure dose rate on the basis of count rate of gamma ray using radiation monitor”. Measurements should be done according to the objectives of the monitoring, what we want to know and what should be understood, for example, what is shown by the ambient dose rate when there are stumpages or high

buildings surrounding the monitoring post. The system enables measurements according to the objectives should be prepared.

- It is necessary to review causes of whether environmental monitoring was useful for actual responses to the accident and revise them. It is also necessary to reconfirm and reexamine the objective “what should be needed” and to reset the monitoring aim “how far we should expect and respond the expectations”. The other means than environmental monitoring should be established in the region where we cannot respond the expectations. To realize this, it is necessary to closely discuss and verify between “monitoring staffs” and “usesers”.
- Monitoring for relief is necessary towards recovery after grasping individual doses of residents exposed at an early stage after accident.

Question & comments

Q (attendee): Issues pointed out in the speaker’s presentation have been already described in the guidance on environmental monitoring in emergency that was drawn up by the Nuclear Safety Commission (NSC) a few ten years ago. As a member of a group drawing up the guidance, I think the main issue is the best use of the guidance was not made in this accident. It should be discussed after reading the guidance.

A (speaker): Since there is a long history, I think that various things must be considered well. However, the fact we could not do is important. Before experts who drew up the guidance retire, we should review the guidance again and not have the same experience in the next accident though such accident should not occur again.

C (attendee): The fact that we cound not do in spite of the existence of the guidance means that the main issue is in the system for emergency beyond technical issues and how we should operate it, which is problem in the government.

A (speaker): I’m now in the field of technology. I think the completion of the technology is to enable a practical use as a final goal and not just making an instrument.

C (attendee): There are NSC guidances, handbooks and manuals. At the extremely early stage after accident, I suggested a responsible person in the MEXT to cope with according to the manuals. However, the reply was that we don’t have to comply with the manuals because we are now in emergency. There were few staffs who could act with correct knowledge about emergency guidance in the early stage after accident. Significant point is to make a system enables operation well-understanding the guidances, to develop human resources and to make a mechanism to be continuously handed down even if governmental staffs change their position in the office every a few years. There would be a gap among the monitoring points even if the number of the points is increased. We should consider what should be the objective and how far we should optimize. In such a situation, the SPEEDI would be helphul. Although a lot of rules are made in a complexed manner, operator of the rules should continue the understanding and the training. The repetition of making more complicated rule after forgetting previous considerations is wrong process. The most significant point is in management. To say about how the government managed the emergency, the government should have requested a help of experts at early stage after accident because they don’t have one hundred percent in knowledge. It is important to continue a training how we should manage the existing rules rather than make a new one.

C (attendee): Such a discussion should be pointed out as issues by JHPS and be connected to

recommendations from the JHPS. It is important to enable to use it efficiently.

Q (atendee): When the ambient dose rate is high, gamma specrum could not be utilized if radioactive plum is coming. Filter is needed to measure concentrations of radioactive nuclides in air. How the monitoring post should be in emergency? How we should measure them?

A (speaker): I think gamma specrum measurement should be prepared in the emergency preparedness and such a tool shoud be reguraly examined.

C (chairperson): Things should be able to be done were not completed in this accident. These issues should be addressed in the recommendations from the JHPS.

Environmental monitoring and its evaluation

(Invited speaker)

- Risk squad was set in the JAEA about ten years ago through the experiences of asphalt and JCO accidents. It is fundamental for risk communication to hear voice from the public at first. To provide information is not significant. We are doing an activity to hear voice from residents and to provide information necessary for the hearing.
- We started a seminar on radiation effect in Ibaragi prefecture. This activity is based on a fundamental concept to make residents live with confidence because residents are feeling a fear of radiation more than necessary. We think that we should start this activity in Ibaragi prefecture at first, since this activity would be necessary in Fukushima prefecture. This seminar was in a lecture meeting style. Presentation was within 30 minutes (at longest 40 minutes). Afterwards, we heard voices of residents and receive questions thoroughly without stopping and escaping. We responded till attendance went home. Master of ceremony is selected from resident side. In principle, time for question and reply was secured for more than 1 hour. After closing, we continued respond to specific questions using a space to experience radiation measurement. We refused to have a lecture’s fee. Instead, residents cooperated to a questionnaire survey.
- The WBC measurements of Fukushima residents consist of not only measurements but also polite explanation of the measurement results, which is similar to counseling. As a result of the questionnaire, it has been clarified that most of all residents felt easy about the radiation effects.
- In Fukushima prefecture, the seminar was held for elementary and junior high school. The target of the seminar was mainly parents, particularly mothers. Five hundreds members from JAEA were entried as staffs for the seminar. Four staffs were selected for a seminar from entried members. Exceptionally, there was a request from priest to hold a seminar for a supporter of a temple. Such a special offer was coped with by staffs in risk communication section in JAEA.
- Recently, there are a lot of questions about decontamination rather than radiation exposure.
- Risk communication to the public ” to ensure human resources” was pointed out as an issue 35 in this draft report, but more important issue than the ensuring the human resources is that we have ever neglected endeavor to improve the people's literacy for radiation. The MEXT reduced education of science. There may have been a consciousness they don’t want to educate radiation due to a memories of Hiroshima and Nagasaki. This effect affected now. I would like JHPS to revise this.

- Risk communication to the public “comprehensibility of radiological protection system” was pointed out as an issue 36 in this draft report. The radiation protection system that we have established was considered in a normal situation. It is necessary to make emergency preparedness available even in the situation without electricity and communication infrastructures.
- Risk communication to the public “utilization of mass media” was pointed out as an issue 37 in this draft report. Partner of the communication through the internet is whole world that includes different culture and society situations, for example, different languages, cultures and religions. The communication through the internet needs huge endeavor. Internet should be considered as a tool for information provision and risk communication should be done in face to face manner. In such a sense, it is important to develop human resources for risk communication in the municipal government and to ensure at least two or three talents to explain about radiation effects in the face to face manner in emergency.
- Risk communication to the public- response to foreign residents and overseas countries was pointed out as an issue 38 in this draft report, but it is important to educate Japanese people at first. There would be no time after an aacident occurs. If knowledge is spreaded, anxiety would be reduced and foreigners surrounded by Japanese people who has sufficient knowledge and information, must not feel any concerns. Panic of elite governmental staffs could be prevented by raising the knowledge level of Japanese people regarding radiation.
- Although information provision to oversea countries is so important, the main causes of the present trouble are due to idleness of governmental staffs and bad cooperation in the government. Staffs relevant to the government should utilize experts.
- Now after two years have passed, the present issue is decontamination and ensuring storage place for its waste. This issue has the same roots as problem of radioactive waste that has been a significant issue for a long time in nuclear energy community. This is the very important issue on risk communication.
- Although communication activities are actively continued focusing a radiation issue, it is not integrated at all. How the residents feel about the different responses among scientific society, Ministry of Environment and JAEA?
- The biggest issue that has never touched is education in school. The main players are teachers. It is necessary to establish education of radiation. How should we support it? We are there for the purpose of information provision. Education is a job of teachers.
- The injury in the affected areas has not been incurred, though two years have passed since the accident occurred on 11 March 2011. I’d like to expect the JHPS to dispassionately analyze various events occurred after the accident and take a step forward as a radiological protection expert group.

General discussions

C (attendee): I think the JHPS recommendation is well-surmmarized, but there may be a part missing. It is frequently said that big problem is SPEEDI informations were not disclosed, but there may be a feeling that SPEEDI has an almighty power in the accident. It is forgotten that there is an inconsistency between informations obtained by SPEEDI and in reality. I think that it must be dangerous to determine the emergency preparedness system

according to the only simulation results. On September 2012, the Nuclear Regulation Authority (NRA) disclosed a map predicting diffusion of radioactive materials in air for 16 NPSs in our country when a severe accident occurs. There were some problems in the modeling and no consideration of geographical features. Mistake of input data was corrected. Some municipalities start examining the storage of stable iodine in spite that they are placed in 100 km apart from the accident point, which would be an overresponse. The cause of this is that the NRA disclosed an inappropriate prediction map. I'd like the JHPS to suggest recommendations to correct such a thing. I'll touch later a fact on disuse of simulation in the ocean.

C (attendee): The SPEEDI is a predicyion system, so the results may not be completely consintent with that in reality. Since the use of the SPEEDI is an agreement in the world after the Chernobyl accident and the accuracy of the prediction results was verified in the international comparison, it must be helphul to decide monitoring method and direction for evacuation. Operational procedures to use the SPEEDI conflicted between the system controlled under the NISA and that has been developed by the MEXT and the JAEA, which leaded to a bad part of response of the accident. This occupies main reasons that made the situation more seirous. The simulation results of diffusuion in the ocean calculated by the JAEA and the JAMSTEC were requested to disclose, but not completed. The details on the SPEEDI have been described in the first JHPS recommendations.

C (attendee): The SPEEDI is a prediction system. It is a principle to design a countermeasure on the basis of measurement results of environmental monitoring, but the results cannot be immediately obtained, so the prediction is needed. It is rather problem to let the prediction have an absolute role. The issue is haw to use the prediction results, for example, it is judged that administration of stable iodine is necessary since the prediction level exceeds previously prescribed thyroid dose level. The simulation results is just a prediction not show a reality.

To say about simulation in the ocean, there must be data for diffusion of heated water discharge in the process of the licensing safety review since all NPSs in Japan are located along the sea shore. It should be pointed out that we had not utilized in spite that there were such simulation data in the ocean. Apart from this, it should be also pointed as an issue that various available data obtained in the past had not been utilized efficiently.

C (attendee): The simulation model in the ocean was used in a committee in the Marine Ecology Research Institute (MERI), but it did not go well due to a barrier between ministries and agencies. The SPEEDI is a rapid prediction tool, and the results are predictions and not show real situation. However, in the emergency preparedness, the SPEEDI occupies an important position, so it should be utilized in a better manner. It is not a better way that the NRA suddenly adpoted what the NRC uses without sufficient knowledge. Revision is frequently needed because they do not have sufficient experiences and knowledges of handling. In spite of recommendation to use the SPEEDI consulting with the MEXT, it did not work. There are a barrier among the ministries and agencies.

C (attendee): Since there was no weather information though TEPCO independently has a prediction system, we reported prediction results assuming a single wind direction and wind verocity at that time. We didn't have an efficient way in prediction because there was no source term data after explosion. After that, radiation exposure was calculated using predicted total released amout of radioactive materials. Nowadays, prediction for upcoming 24 hours is carried out when emergency situation starts preassuming drop of

power supply due to earthquake. For instance, we predicte a contamination map after continuous release for 24 hours at a rate of one hundred million Bq/s and change of the wind direction for upcoming 24 hours. Using these informations, logistical support organization is set up on the basis of the present experiences in the accident and it is predicted when the wind direction will change to the location of the organization (when the plume will diffuse and when the wind direction is serious for the organization). The countermeasure is examined so as not to be contaminated by restoring the windows when the windowpane of the logistical support point has been broken. We can appropriately suggest a direction of evacuation whenever the instruction of the evacuation is issued if the wind direction is known. Without depending on the SPEEDI, we think the source term can be predicted by precalculating simplified chart of the source term assuming a series of event, for example, how high radioactivity it has in the case of ventilations of a reactor without fuel failure, with a few tens percents of core meltdown or with various wind direction and verocity.

C (attendee): Although the target of the JHPS recommendation is mainly people who are directly affected by the accident, it should be also considered for people who are not directly affected. People who live in west areas of Nagoya city didn't have a sense of ownership. The accident was a matter of other people's affairs for them. The interest of the accident is low. Big confusion happened when fireworks made in Fukushima area had planned because people didn't study the accident at all. I would like the JHPS to also consider about non-affected people.

C (attendee): In selecting issues, there are a lot of considerations, for example, things should be done in normal situation and in transition period from normal to emergency situations, additionaly needed things and originally exisuting things should be utilized. I would like the JHPS to select issues including whether or not there is a difference in risk communication between normal and emergency situations.

C (attendee): There must be also difference in time series, for example, one week, one month and one year after the accident. Method of risk commnunication would be varied according to the distance from accidental site. Recommendation had better be examined as a matrix of time and distance.

Concluded

Appendix II Voice record at session 2 in Special Symposium II of the Japan Health Physics Society on the second Fukushima project (22 February 2014)

The JHPS Special Symposium II on the second Fukushima project was held at Koshiba Hall in Tokyo University on 22 February 2014. After the first session in the morning to share information on rehabilitation activities in Fukushima, a draft of the JHPS recommendations for issues raised after reviewing the investigative reports was introduced. Members on the floor discussed these recommendations with each other including previously gathered comments. The voice recod is as follows:

First half

Speaker's reply to previously gathered comments

- There was a previous comment on the further enhancement of coastal sea area monitoring. As the aim of this comment seems to be associated with radiation exposure owing to the intake of sea products, I think that recommendation 9-1 is related to the comment. Recommendation 11-3 is also related to it.
- There was a previous comment on the utilization of shelter for evacuation, but this has been addressed in the sentence "an emergency evacuation strategy including methods of communication by satellite phone should be provided in the nuclear emergency preparedness plan" in recommendation 16.
- There was a previous comment on the response to the understanding of radiation measurement. This issue has already been included in recommendation 18-1. Recommendation 35-1 is also related to it. I would like to touch on this comment again in a later session today.
- There was a previous comment on the revision of the radiation dose criterion that should be selected from between 1 and 20mSv/y instead of 1mSv/y. This has also already been touched on in recommendation 19-1, which gives a more comprehensive opinion.

Question & comments

C (chairperson): Regarding the comment on the difficulty of achieving 1mSv/y, decontamination is normally decided by considering the balance between the avoidable dose and the required cost and labor. If anyone has a comment on this or the speaker has an additional explanation, please go ahead.

C (speaker): I think that the ICRP and government simply adopted a value of 1mSv/y as a long-term target for decontamination. There may be an opinion that 1mSv/y should be immediately achieved in some areas. However, even in the same city, town or village, there are various contamination levels. When 1 mSv/y is achieved in low-level contaminated areas, there will be an expectation to achieve 1 mSv/y even in the high-level contaminated areas. However, it would be difficult to achieve 1mSv/y in such areas. If anyone who knows Fukushima residents well has an opinion on this, please let us hear it.

C (chairperson): There is no other way except to adopt an option using the characteristics of each scene on a case-by-case basis in a situation between normal and emergency exposure, that is, the existing exposure situation. On the other hand, deciding the dose criterion on a case-by-case basis may be criticized when the criterion is freely changed. I think that people have come to understand that some requests are impossible to achieve with the passing of time since the accident. Because of this, the best solution appears to

be to focus on high priority areas, e.g., public areas in relation to infrastructure to support life. Regarding this point, I'd like to hear from attendees.

C (attendee): As given in recommendation 19, it is true that the dose criterion should be decided with the active cooperation and understanding of stakeholders. However, after hearing a presentation in the morning session today, I understand that this is fairly difficult. It is very difficult to strike a balance between an ideal target and reality. In the second set of recommendations, it is better to recommend the manner in which experts should always support society.

Q (chairperson): Such a criterion is ultimately decided by politics. On the other hand, politicians don't like to take political risks. The national and local governments are in charge of national and regional matters, respectively. Generally, it is possible to show the numerical values in emergency and normal situations using science. In the stage of transition from an emergency to a normal situation, difficult decisions are necessary because the decision process requires the situation to be monitored and agreement to be obtained with people who will be affected by the decision. What political decisions are necessary?

A (attendee): From the viewpoint of government, any decisions would be administrated in a fair and impartial manner. I think the decision-making process is difficult, but local government must follow the national standard if the national government provides a clear direction. There is a possibility that residents will have a fear of radiation effect owing to exposure exceeding specific numerical values if they do not understand their meaning. It is important to provide education on radiological protection in elementary school and junior high school. Currently, we are struggling to achieve 1mSv/y but successfully reducing the dose from 20mSv/y.

C (attendee): From the responses of residents at the Decontamination Information Plaza in Fukushima city, there are some people who think that they will develop cancer if they are exposed to radiation exceeding 1mSv/y. I found that the number 1mSv/y has a strong impact on people. Some people become anxious if the government sets a standard then the contamination level exceeds the standard by a small amount. For instance, there are also some people who want to make inspections by themselves by purchasing a measurement tool even if there is a label on the food package saying "passed inspection", meaning that the food satisfies the standard for foods of 100Bq/kg. When a standard is determined, it should be shown as a band not a single value by considering how residents think about it. Moreover, an explanation, for example, that radiation exposure exceeding the standard does not have any immediate effect on health, should be added.

C (attendee): I found that it is easy to misunderstand a numerical value for the standard, which leads to anxiety. I'm sure that there was a presentation about hazard maps using red, blue and yellow colors at the IRPA international conference. I would like JHPS to propose such a method to reduce anxiety.

A (speaker): I also think that it is difficult to get residents to understand the meaning of the numerical value. I don't have an answer to the question about how we should explain it so that it is understood. The insufficient explanation of the numerical value is clearly an issue.

C (speaker): From my experiences of dialogue in meetings to directly communicate with Fukushima residents held many times after the accident, the significant point for experts is that they have to study a great deal of frequently changing things, such as various standards produced after the accident, the ambient dose rate and evacuation areas, to

respond to Q&As as radiological protection experts. I found that the accumulation of knowledge is necessary for experts in charge of the communication of risk to residents. Also, it is difficult to correctly grasp the intention of some questions, whereas it is important to give explainations in an easy-to-understand manner.

C (chairperson): Although people tend to focus on the highest radiation dose, there is a large gap between actual individual doses and doses estimated from ambient doses obtained by survey meters because people normally do not go to the high-dose places and do not always eat highly contaminated food. In other words, experts should explain that individual dose levels in an area are not always high even if there are a few high-dose places in the area. Also, experts should explain how we should respond in the case of partially high-dose area, whereas priority of the response to specially-high-dose area is high. Regarding this situation, it is necessary to provide explanations by experts in an easy-to-understand manner. The understanding of residents cannot be obtained if such information sharing by the government is impossible. In the case of internal exposure, radioactive materials move in the human body with time after their intake. It is very difficult to simply estimate internal exposure only using data obtained by a whole body counter (WBC). There will be no answer if nobody analyzes the movement of radioactive materials after their intake. This situation has not been understood by the public. Experts can understand this situation, but cannot explain it to the public if the public no longer trust experts. People or channels of communication to connect the public and experts are important. I think that high-quality information provision has not yet been achieved because of the lack of connection between them.

C (attendee): I had the opportunity to talk to residents regarding the radiation risk corresponding to 1mSv/y from the standpoint of a radiological protection expert, but in some cases, the aim of the communication was confused with the promotion of nuclear power plants. There are people who cannot trust staff to objectively discuss nuclear power plants because they always claim that they are safe. I found that we should distance ourselves from the debate on nuclear power plants when discussing radiological protection.

C (chairperson): People frequently tend to think in polar terms about nuclear power being good or bad, but nuclear power has both good and bad points. It is necessary to construct a system to select various options.

C (attendee): I don’t have the confidence to clearly explain the meaning of the criterion, but there must be examples of successful experiences in explaining the criterion to the public. It is effective to share the successful experiences among experts because such successful experiences were archived by the organization. According to recommendation 19, radiological protection criteria should be determined by considering a balance among reference levels. The fact is that the radiological protection criteria were determined day by day when the criteria became necessary. However, to formulate the criteria, the same fundamental concept was used in the same manner. There was consistency in the concept used to derive practical amounts (e.g., Bq/kg) from the dose criteria, but the numerical values differed depending on the case in which practical amounts was used. As an example, the clearance level was 100Bq/kg before the accident, but a similar standard for disaster waste was changed to 8,000Bq/kg, which was difficult for the public to understand. I heard that it is also difficult for people with some knowledge of radiological protection to explain the difference between 100 and 8,000Bq/kg. Except for the case of standards for foods, it may be difficult to decide in advance practical amounts in the case

of an accident, but I think it was necessary to prepare in advance for the possibility of an accident by considering the distribution of goods.

Q (chairperson): In the United States, what process is in decision-making and politics?

A (attendee): Radiological protection criteria are determined by the NRC. There is staff working under a few NRC members. The staff is similar to the members of the Nuclear Regulatory Agency in Japan. The members of the NRC clearly decide the criteria. After hearing this decision, the staff elaborates the concepts. Moreover, the NRC members always suggest that staff adopts the opinions from stakeholders. There is a system to ensure that public hearings are frequently held for every issue, the results are disclosed on the NRC homepage and opinions on the results can be sent to the homepage. I have the impression that the NRC discuss standards carefully, taking a long time to determine each standard, whereas this leads to different opinions on whether the standards are good or bad.

C (chairperson): In my understanding, the NRC members communicate well, actively participating in public hearings and symposia. The actions of members to actively hear opinions at various opportunities seem to lead to effective decision making.

Latter half

Speaker's reply to previously gathered comments

- There was a previous comment on the inadequacy of getting the public to wear personal dosimeters. However, in the current draft of the recommendation, recommendation 29 suggests that a system to enable the investigation of external exposure using personal dosimeters should be established. I would like to discuss this with attendees later.
- There was a previous comment on whether the control of occupational exposure is adequate or not. As I don't know much about the radiation control at the site, I would like to discuss this with attendees later. The relevant recommendation numbers are from 31 to 34.
- There was a previous comment on responses to the lack of public understanding of radiation measurement, but this point has already been raised in recommendation 35 under the title "spreading understanding of radiation effects. I would like you to understand that it includes radiation measurement, radiation protection and radiation effects.
- There was a previous comment on discussion with stakeholders to examine international standards for reference. In recommendation 35-5, we gave an example of an explanation of radiation exposure suggesting that risk communication systems supported by experts should be established, but we did not touch on the examination of international standards in terms of discussion with stakeholders.
- In the morning session today, there was a report on the current status of contaminated water in the Fukushima Daiichi NPS. In the current draft of the recommendation, contaminated water was not mentioned, but I would like to add this point as an item of risk communication.
- From now on, the draft recommendations will be revised in accordance with the comments made today. The second set of recommendations will be completed after public consultation through the JHPS homepage.
- As the comment on new setting of registration for questions in the JHPS homepage is not an opinion related to this recommendation but is a comment directed to JHPS itself, I will not discuss this comment.

- There was a previous comment on the lack of clarity from the viewpoint of 7W2H and the necessity to give priorities in each recommendation. The target of this recommendation is not touched on in this draft recommendation. This is because this draft recommendation was written under the assumption that people who read it will act from their own standopoint. In this sense, I would like you to understand that we drafted the recommendations without giving a target by listing what needed to be done after the accident and what actions are necessary.
- There was a previous comment on the construction of a system to broaden important international standards in an easy-to-understand manner by observing the activities of ICRP and IAEA. As this comment is not an opinion related to this recommendation but one directed to JHPS itself, I will not discuss this comment.

Question & comments

C (chairperson): A failure after the Chernobyl accident was to set a target level of 1mSv/y for all areas immediately after the emergency. It is necessary to avoid such a situation. In the existing exposure situation defined by ICRP, it is also necessary to avoid choosing a value of 1mSv/y suddenly, and the reference level should be decreased in a stepwise manner. This time, confusion occurred because 1mSv/y was suddenly chosen as the reference level. If a broad area is contaminated, it will be difficult to reach this level, resulting in disappointment. For example, it took approximately 30 years to reach this level after a test on a nuclear weapon. Lessons from the Chernobyl accident have been learned. In the same manner, we have to learn lessons from the Fukushima accident, so we at JHPS have elaborated a second set of recommendations. IAEA sets safety standards, but there may be missing because not all information about the situation at the accident site may have been passed on. In this sense, this recommendation would be helpful, so I would like you to adopt it.

C (attendee): As I heard that local government staff worked hard to revise the emergency preparedness plan, I would like to discuss this topic. For nuclear emergency preparedness, it is necessary to consider both optimization and justification. If the evacuation area becomes larger, the number of evacuated residents will greatly increase. This may cause problems if all residents start to evacuate simultaneously. Consideration of the protective measures and the timing of evacuation while instructiong residents about other protective means, e.g., staying indoors, is an issue in making an emergency preparedness plan by local government. After the Fukushima accident, residents were instructed to take the protective measures of staying indoors, evacuation and restricting their intake of food and beverages. I would like you to investigate the effectiveness of these measures and review them from a critical viewpoint. Restricting the intake of food and beverages could prevent large internal exposure. This should be verified as soon as possible to help with the formulation of regional emergency preparedness plans. After the Chernobyl accident, as stated in the WHO report, there was a case of death from thyroid cancer caused by the intake of food and beverages, especially milk. As food and beverages were restricted shortly after the Fukushima accident, internal exposure may have been markedly reduced. Unfortunately, investigation of the radiation exposure of residents has not been completed yet. I'm hoping that the government and JHPS will actively progress this investigation.

C (chairperson): I was appointed as a special advisor to the Cabinet. As pointed out before, a failure after the Chernobyl accident was not to impose restrictions on food and beverages. If restrictions on food and beverages work well, the effect on reducing internal exposure

would be significant. In this sense, I think it is very important to verify the effect of the restriction after the Fukushima accident.

C (attendee): The process to determine the dose limitation in an emergency of 250mSv was not carried out in a transparent manner. I think the process used to make various decisions should be clearly disclosed to the public. In the discussion on raising the dose limitation in an emergency to 500mSv, although this idea was abandoned after consideration by members of the Cabinet, it should have been decided on the basis of scientific criteria. There were some cases in which the process was not clear, and the decision-making process was like a black box. Regarding this point, I would like to make a recommendation. In the release of water contaminated with low-level radioactive material to the ocean, the information was not communicated well. The most significant point is the response to the question of which law should be used, the Act on Special Measures Concerning Nuclear Emergency Preparedness or the Nuclear Reactor Regulation Law. There was an idea that the release was the operator's responsibility and that the government didn't have to publicize it actively. Or the government was not aware of the needs of information provision on release of contaminated water. In this recommendation, I would like you to include the importance of transparency in the decision-making process and of public relations because the process was like a black box.

A (speaker): As I didn't enter the discussion in the morning session, I would like to reply here. There was a comment on enhancing education on radiation as a practical science. This point has already been simply described in the draft recommendation. Regarding the comment on the request to make a recommendation about compensation, we are elaborating this recommendation from the standpoint of a radiological protection expert. As compensation for the effects of the accident is a social science and out of our expert field, it is difficult to get involved it in this recommendation.

C (attendee): Regarding the issue of compensation, we now have a nuclear reactor being decommissioned. This reactor is now under regulations within the framewok of the operation of nuclear reactors, which is an issue. I think that this issue is difficult to discuss within JHPS, but it may be possible to respond to residents around the reactor. As this reactor is now being decommissioned, the Act on Special Measures Concerning Nuclear Emergency Preparedness no longer applies to this reactor. However, the residents around the reactor understand that it is a nuclear facility, so I think that communication of the radiation risk is an important issue. Regarding the issue of low-dose radiation exposure, local residents and their children are currently deeply concerned about this issue. I hope that policies on providing information on the effects of low-dose radiation, risk communication and emergency preparedness will be standardized by utilizing lessons learned from this accident.

C (chairperson): As mentioned in the morning session, children in the Fukushima area have a good understanding of the effects of low doses of radiation because there is so much information around them. On the other hand, the understanding of people who live in distant areas is poor. I'm concerned that children moving to such areas when they grow up might be isolated. An important discussion held by ICRP was about equity. For example, there is a difference in equity between the location of nuclear power plants and consumption area of electric power; people in the consumption are exposed to little risk. From a nationwide viewpoint, there may be no problem in generating and consuming the electric power in one country, but there is no balance in the distribution of risk among these areas. ICRP has discussed how to explain this inbalance when they explain risk

management. It is necessary to improve educations on radiation and risk not only in the affected area but also in the entire country.

C (attendee): Regarding education on radiation, risk communication in the current draft recommendation seems to be for residents close to the site, but there is little mention of education on radiation taking Japan as a whole into consideration. I would like you to add this point and take account of the follow-up after the recommendation.

C (attendee): I'm now examining how we should improve education on radiation, so I'm expecting JHPS to provide an answer.

C (attendee): Regarding the inadequacy of getting the public to wear personal dosimeters, the speaker mentioned the differences between the previous comment and the current draft recommendation. The purpose of the recommendation from JHPS is to obtain the external individual dose correctly. I think that the meaning of the previous comment is that the ambient dose should be used in a complementary manner without assigning responsibility for measuring the personal dose to the individuals. The fundamental considerations in both opinions are the same, but I think that the unclear meaning of the distribution of personal dosimeters produced these separate opinions.

C (attendee): There was a discussion last year about what protective measures are effective when evacuated residents decide to return home. The protective measures to minimize the dose are environmental monitoring, external dose assessment using personal dosimeters and internal dose assessment by WBCs to understand the radiation doses measured by themselves. To underline the importance of protective measures such as personal monitoring, we planned the morning session to include a speaker from the Cabinet Office to outline governmental protective measures for safety and reliability. In the existing exposure situation, I think that people should not be forced to wear the personal dosimeters, which are just one effective tool among a range of protective measures. However, as pointed out before, it is necessary to analyze the results obtained from personal dosimeters and WBCs without adopting the output as it is. I think that JHPS should play a role in preventing misunderstanding of the results of the measurements. In the recommendation, the action to provide comprehensive information and knowledge should be included.

C (chairperson): I'd like to discuss a difficulty in dose assessment. Normally, the ambient dose is measured at a height of 1m, but when the target of the dose assessment is a small person such as child, it is necessary to convert the dose to one at a lower height, which means changing the dose conversion factor. In other words, there are many cases where a change in the conversion factor depending on the age is needed. In addition, there may also be cases where differences in the patterns of personal behavior prevent use of a representative value to assess each individual dose. In the case of internal exposure, the situation becomes more complicated. The internal dose varies with not only the representative radioactivity concentration in foods but also with what is ingested, when it is eaten and the age because of differences in the tissue size and metabolism. It is difficult to be convinced of the accuracy of a given radiation dose. Internal and external doses simply indicate values for a representative person. Actual individual doses vary with the body size and metabolism. In this sense, numerical values obtained by radiation measurement or dose assessment should be understood as only indicating a level of risk. The risk level shown by a risk band provides sufficient explanation in normal cases. On the other hand, in cases where detailed numerical values are actually necessary, communication of the risk becomes difficult.

C (attendee): In the morning session, there was a discussion of segmentation in the local community, which was also found in a family. Education on radiation is necessary not only for children but also for parents who raising children. I was afraid that this would not be mentioned in the recommendation, but I'm delighted to hear the speaker's explanation of the reason including the speaker's intention to consider that people who read this recommendation will voluntarily act from their standpoint. I would like you to add such a reason to the recommendation.

A (speaker): I acknowledge your comment. I would like to add it to the background section on the fundamental policy in the elaboration of recommendations.

C (attendee): I think it is difficult to provide sufficient education on radiation in junior high school because of the crowded curriculum. The budget for the Hakarukun (mobile simple survey meter) business was discontinued, but in these times, it is necessary to continue it. Regarding stakeholder involvement, I think that the discussion has continued without any consideration of the benefits of radiation, despite there being both risks and benefits. As the discussion on risks and benefits has only been on whether radiation is safe or dangerous, this should be included in the recommendation.

C (attendee): I heard from a teacher in Fukushima prefecture that there is a shortage of time at school to educate students on radiation and he also doesn't know what he should teach. Moreover, there is an opinion that students should not measure radiation because of serious concerns about the effects of radiation of the parents. It is difficult to determine what should be taught and how it should be taught without generating fear about radiation. I would like JHPS to carry out activities to enable the public to understand that experts are now discussing such points.

C (attendee): Numerical values and units of radiation are difficult to understand, and in many cases, people often understand in terms of goodness or badness and want experts to reply in these terms. If too much information is provided by experts to explain radiation, the communication would become difficult to understand because of information overload of the public. Not only radiation but also all other applications of science are not only evaluated in terms of whether they are safe or dangerous, which should be a fundamental part of education. Otherwise, explanations by experts will not be understood by the public.

C (chairperson): I think that this was an issue in the era of the former Prime Minister Tony Blair in U.K. He considered that the most significant problem in the country was education, which he emphasized. At that time, SATIS (Science and Technology in Society) was proposed. There are many aspects of sciences and technology that are complex and difficult to understand. However, if their understanding is not acquired owing to a lack of education, a tendency to reject sciences and technology without understanding them may occur. For this reason, education on scientfic activity has been focused on in U.K. society.

Q (attendee): Today, I participated in a symposium about supporting public health after the Fukushima nuclear accident. A misunderstanding was witnessed there, e.g., the figure of 1mSv/y was strongly defended. There is an impasse that returning home and rehabilitation cannot progress because of the insistence of reaching the target of 1mSv/y. Some one has to announce that it is mistake to prevent people from returning home without achieving the target of 1mSv/y. On the other hand, there are some issues regarding what should be adopted as a numerical value for the annual individual dose and who should announce it. If the Atomic Energy Society in Japan announces it, it would

sound like a voice from nuclear community. I thought of JHPS and the Medical Association as alternative candidates, but the Medical Association strongly defended the value of 1mSv/y in today's symposium. To progress rehabilitation, I think that we should make a statement on the importance of not insisting on 1mSv/y. What do JHPS members think about this?

A (chairperson): Regarding the points you mentioned, there is a description of setting the target dose in the ICRP publication. Contamination over a large area or the situation after an accident is addressed under an existing exposure situation. ICRP Publication 82 states that various doses below 10mSv/y should be selected. In addition, ICRP Publication 111, which was prepared to ensure radiological protection after an accident, states that the existing exposure situation should be controlled to the lower part of the dose range between 1 and 20mSv/y. As an answer has already been given, we had better just understand this. The problem of who finally decides the annual individual dose should be tackled by the government by considering the age distribution of the residents and the characteristics of the local area. I think that this issue of risk management is somewhat beyond the scope of medical doctors, who normally make diagnoses. Considering the past process used to determine 1mSv/y as the maximum dose for the public, the use of 1mSv/y as a standard during the rehabilitation or restoration period was a big mistake. In the ICRP publication, it is stated that the target dose should be reduced from 20mSv/y to 1mSv/y in a stepwise manner. It is sufficient to respond to the issue of rehabilitation by simply understanding such points. The objective of radiological protection is to optimize protection. To prevent from the failure after the Chernobyl accident such as the target value of 1mSv/y was announced in a dogmatic manner, various systems were completed in approximately 20 years. However, there are few people who understand this failure.

C (attendee): Hearing the comments from floor, I've felt that there may be misunderstanding. I think that the background on this matter is not well related to whether 1mSv/y is safe or not. They cannot understand the issues involved, which is a problem. As the percentage of people suspected to have cancer upon thyroid inspection has increased since the accident, the interest of people has changed from the topic of 1mSv/y to whether or not children's health can be protected. In Fukushima prefecture, we are investigating the reason for the increased incidence of suspected cancer upon thyroid inspection and chromosome investigation. In addition, when we talk to residents, we inform them that we will make careful judgments after 3 to 5 years of continuous investigation because the investigation has only just started. Some residents want to trust people whose opinions are similar to their own idea and also want to believe opinions opposite those of the government because they have become tired of the confusion caused by 3 years of politics. In such a situation, the announcement that a dose of more than 1mSv/y is acceptable may arouse resident's antipathy.

C (chairperson): In Fukushima prefecture, the individual dose greatly varies depending on the location. The external exposure of residents due to radioactive plume probably exceeded 1mSv. When investigating the effects of radiation, dose assessments and surveys on the effects on health based on epidemiological investigations are two essential aspects, and opinions based on one of the aspects are likely to be erroneous.

C (attendee): My impression is the unclearness of what should be explained. It is important for JHPS to explain to the public in an easy-to-understand manner, clarifying the situation from their viewpoints.

Q (speaker): I would like to reconfirm the consensus of the audience. I am now planning to

add a recommendation regarding contaminated water in the part in relation to risk communication. What do you think about this? As there is no objection, I'll add it in the recommendations.

C (chairperson): As I mentioned before, there are clear descriptions in ICRP publications 82 and 111. There are various ways to return to a normal situation from an emergency situation. For this reason, in the ICRP publications, only range of the radiation dose is given to ensure an allowance and flexibility. A final value within the range of the radiation dose will be determined by the government. If the value is chosen after hearing various opinions, a convincing consensus can be obtained to some degree. In this sense, the process, that is, the procedure followed, is important.

C (speaker): We would like to complete the final draft recommendation including today's discussion. In addition, before finalizing this recommendation, we will again collect comments from JHPS members through consultation via our homepage.

C (chairperson): As the draft recommendation is uploaded on the JHPS homepage, I hope we will receive more frank comments. Thank you for your participation in this symposium.

Concluded