4

Overview of the damage and how it spread

The Commission examined the post-disaster decisions, policies, measures and communications implemented by the government and how they were presented to and perceived by the general population living near the Fukushima Daiichi Nuclear Power Plant. We also investigated, from the standpoint of the residents, the degree that government measures helped their evacuation from the evacuation zone and supported them after the event.

4.1 Overview of damage from the nuclear power plant accident

As a result of the accident, approximately 900 Peta Bq of radioactive substances were released. In radiological equivalence to iodine 131, this is approximately one-sixth the amount of emissions released in the Chernobyl nuclear accident. There are now vast stretches of land—1,800 square kilometers—of Fukushima Prefecture with a potential air dose rate of 5mSv per year or more.

The residents are greatly concerned about their internal and external exposure. However, this can only be estimated, as it is impossible to accurately determine the specific radiation exposure of individuals due to a variety of factors. An estimation of individual exposure is found in the data gathered by the Fukushima Prefecture in the "Prefectural People's Health Management Survey" (Ken-min Kenko Kanri Chosa), which was conducted on residents of the prefecture, and released in June 2012. This estimated the cumulative external exposure doses of residents in certain regions of the prefecture based on a record of their activities during the first four months following the accident. In advance of the survey for the entire prefecture, approximately 14,000 residents were surveyed, excluding nuclear plant workers, from three towns and villages where the air dose rate was relatively high. The results show that 0.7 percent of the residents were exposed to 10mSv or more, 42.3 percent were exposed to between 1mSv and 10mSv, and 57.0 percent were exposed to 1mSv or less over this four-month period. While these figures are generally low, the residents continue to be concerned about their exposure, so the government must continue to conduct thorough and detailed surveys.

1. *Degree of contamination*

The source term, or radiation released into the atmosphere by the accident, is estimated to be approximately 900Peta Bq (Iodine: 500Peta Bq, Cesium 137: 10Peta Bq).[1] In radiological equivalence to iodine 131, (International Nuclear Event Scale [INES]), this is approximately one-sixth of the 5,200Peta Bq that was calculated through INES to have been released by the Chernobyl accident.[2] The released radioactive cesium from the Fukushima Daiich Nuclear Power Plant[3] was deposited in the soil from precipitation as shown in Figure 4.1-1.

According to the Ministry of the Environment, the contaminated land area in Fukushima Prefecture with a potential annual air dose rate of 5mSv stretches over 1,778 square kilometers. Some 515 square kilometers could have a potential annual air dose rate of more than 20mSv.[4] On the other hand, it is estimated that the area contaminated by cesium 137 released by the Chernobyl accident spanned a total area of 10,300km^2 (concentrations over 555kBq/m^2) over the three countries of Belarus, Ukraine and Russia in 1986. An area of 3,100km^2 was contaminated in excess of 1,480kBq/m^2. [5]

2. *Number of evacuees*

Twelve municipalities of Fukushima Prefecture lie within the designated evacuation zones, and by August 29, 2011, the number of evacuees had reached a total of approximately 146,520 people. These included approximately 78,000 from the "Restricted Area" (within a 20km radius from the Fukushima Daiichi Nuclear Power Plant), approximately 10,010 people from the "Deliberate Evacuation Area" (areas outside the 20km radius from the power plant, where there was a concern that cumulative air dose might reach 20mSv within a one-year period after the accident), and approximately

[1] TEPCO, "Fukushima Daiichi Genshiryoku Hatsudensho Jiko ni tomonau Taiki e no Hoshutsuryo Suitei ni tsuite (The Estimated Amount of Radioactive Materials Released into the Air and the Ocean Caused by Fukushima Daiichi Nuclear Power Station Accident Due to the Tohoku-Chihou-Taiheiyou-Oki Earthquake 'As of May 2012')," May 24, 2012 [in Japanese].

[2] For an estimate of the source term, see Reference Material [in Japanese] 4.1-1.

[3] For the purpose of comparison with the Chernobyl accident, only cesium 137 is considered in this section.

[4] MOE, "Josen-to no Sochi-to ni tomonatte Shojiru Dojo-to no Ryo no Suitei ni tsuite (Estimates on volumes of soil and so forth removed caused by decontamination measures etc.)," 2011 [in Japanese].

[5] IAEA, "Environmental Consequences of the Chernobyl Accident and their Remediation: Twenty Years of Experience, Report of the Chernobyl Forum Expert Group 'Environment'," 2006.

Figure 4.1-1: Cumulative dose of cesium 137 (as of July 2, 2011)

** For the convenience of explanation, the Commission has filled in the name of each prefecture and the distance from Fukushima Daiichi to the figure originally crafted by Ministry of Education, Culture, Sports, Science and Technology.*

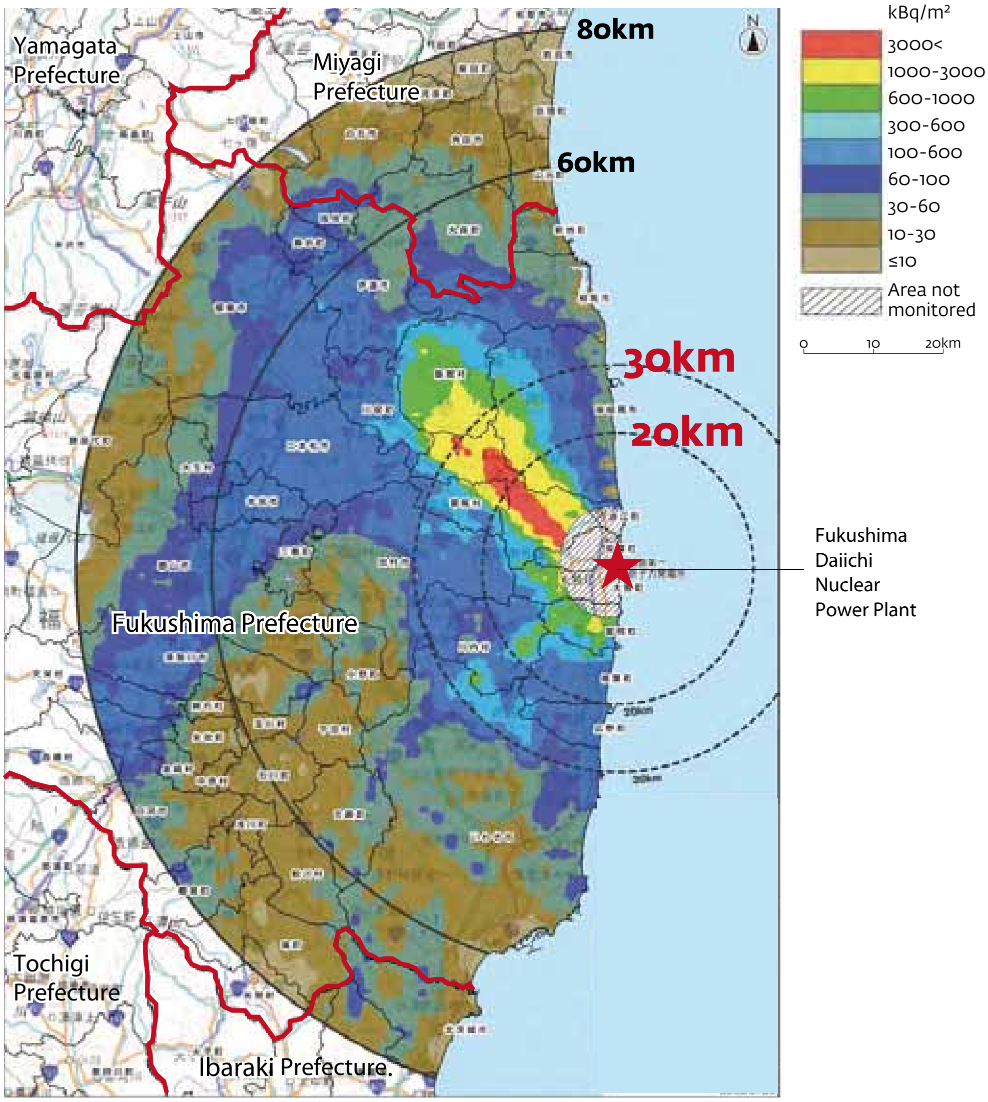
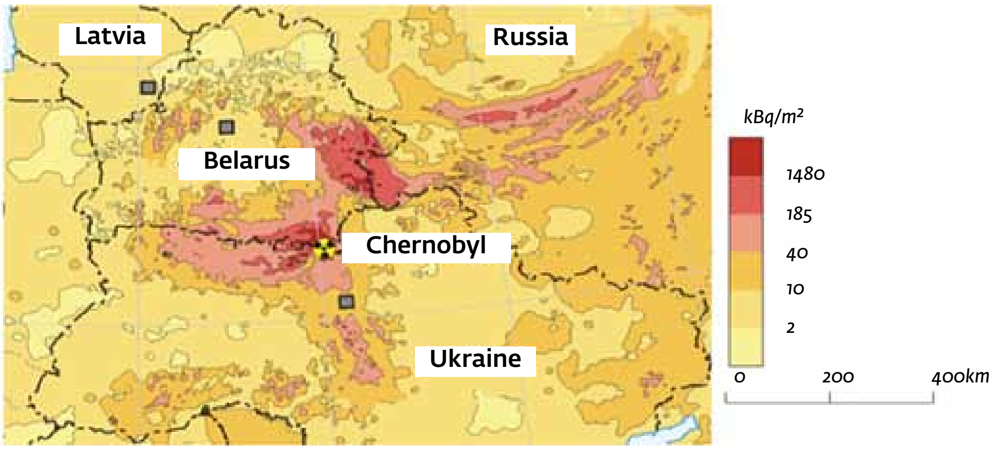


Figure 4.1-2: Map of Deposition of cesium 137 caused by the Chernobyl accident [6]



58,510 people from the "Evacuation-Prepared Area in case of Emergency" (areas 20-30 km from the power plant, excluding the Deliberate Evacuation Area and the zone where sheltering orders issued on March 15, 2011 had been lifted).[7]

In comparison, it is estimated that 116,000 people from Belarus, Ukraine and Russia had evacuated within one year of the Chernobyl accident. In short, the number of evacuees from the evacuation zone caused by the Fukushima accident is roughly

[6] European Commission Joint Research Centre Environment Institute, "Atlas of caesium deposition on Europe after the Chernobyl accident," 2001.

[7] Support Team for Residents Affected by Nuclear Incidents, in Cabinet Office, "Sanko Shiryo (Reference Material)," Document No.5-2 of the 6th Meeting of Council for Drawing up New Framework for Nuclear Policy, September 2011, 2 [in Japanese].

Table 4.1-1: No. of persons evacuated from the evacuation zones [8]

	Restricted Area	Deliberate Evacuation Area	Evacuation-Prepared Area in case of Emergency	Total (no. of persons)
Okuma Town	*Approx. 11,500*			*Approx. 11,500*
Futaba Town	*Approx. 6,900*			*Approx. 6,900*
Tomioka Town	*Approx. 16,000*			*Approx. 16,000*
Namie Town	*Approx. 19,600*	*Approx. 1,300*		*Approx. 20,900*
Iitate Village		*Approx. 6,200*		*Approx. 6,200*
Katsurao Village	*Approx. 300*	*Approx. 1,300*		*Approx. 1,600*
Kawauchi Village	*Approx. 1,100*		*Approx. 1,700*	*Approx. 2,800*
Kawamata Town		*Approx. 1,200*		*Approx. 1,200*
Tamura City	*Approx. 600*		*Approx. 4,000*	*Approx. 4,600*
Naraha Town	*Approx. 7,700*		*Approx. 10*	*Approx. 7,710*
Hirono Town			*Approx. 5,400*	*Approx. 5,400*
Minamisoma City	*Approx. 14,300*	*Approx. 10*	*Approx. 47,400*	*Approx. 61,710*
Total	*Approx. 78,000*	*Approx. 10,010*	*Approx. 58,510*	*Approx. 146,520*

equivalent to the number of evacuees from the Chernobyl accident (see Table 4.1-1). [9]

3. *Overview of residents' exposure to radiation*

As of June 2012, there are no confirmed cases of serious physical health effects caused by the radioactive substances released from the power plant. However, it is an unmistakable fact that radioactive substances were released, so residents did have some degree of exposure.

Since cumulative exposure varies, it is impossible to examine the cumulative exposure in each individual. Very few people, of course, carried radiation dosimeters with them to gauge external exposure during the emergency period. And whole body counters (WBC) have not been widely used to measure internal exposure.

a. Exposure of the residents to low-dose rate radiation

One means of examining external or internal exposure to radiation is to perform screening examinations, which measure the radioactive contamination on the body surface. Screening examinations show the body contamination level[10] by measuring the radioactivity released from radioactive substances on the body surface. This examination can ascertain if clothing and body surfaces have been contaminated, and can also be used as a primary check for the possibility that the person has been internally exposed due to inhalation of radioactive iodine, etc.

The contamination level figure in itself does not express the degree of external exposure. Even for persons with a relatively high level of contamination, a sizeable amount of contamination can be removed if they undress and have their bodies decontaminated. Consequently, a high level of contamination does not necessarily imply a corresponding high degree of external exposure.

The results of the screening examinations performed on evacuated residents

Table 4.1-2: Results of screening examination performed on evacuated residents for the period from March 14 to April 14, 2011

Figures from screening results	No. of persons examined
Less than 13,000cpm	*150,516*
13,000cpm to 100,000cpm	*879*
More than 100,000cpm	*102*
Total	*151,497*

[8] Support Team for Residents Affected by Nuclear Incidents, in Cabinet Office, "Sanko Shiryo (Reference Material)," Document No.5-2 of the 6th Meeting of Council for Drawing up New Framework for Nuclear Policy, September 2011, 2 [in Japanese].

[9] IAEA, "Chernobyl's Legacy: Health, Environmental and Socio-economics Impacts and Recommendations to the Governments of Belarus, the Russian Federation and Ukraine," 2005.

[10] External exposure means exposure to radiation from radioactive substances outside human body. Body contamination means that radioactive substances attach to clothing or body itself.

between March 14 and April 14, 2011 are shown above.[11]

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.[12]

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). [13]

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%*

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,[14] 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). [15]

Units for radioactive substances and radiation

Becquerel (Bq)

One Becquerel is defined as the quantity of radioactive materials that decays per second. This unit is used to express the quantity of radioactive materials.

[11] Documents from Fukushima Prefecture

[12] The World Health Organization (WHO) has made estimates not only for external exposure dosage rates, but also for internal exposure.

[13] Fukushima Prefecture, "Kenmin Kenko Kanri Chosa 'Kihon Chosa' no Jisshi Jokyo ni tsuite (Status of Implementation of 'Basic Survey' for Prefectural People's Health Management Survey)," at the Seventh Meeting of the Review Committee for the Fukushima Prefecture "Kenmin Kenko Kanri Chosa (Prefectural People's Health Management Survey)," Document 1, June 12, 2012 [in Japanese].

[14] See 4.4.1.

[15] TEPCO, "Fukushima Daiichi Genshiryoku Hatsudensho Sagyosha no Hibakusenryo no Hyoka Jokyo ni tsuite (Status of Exposure Dose Evaluation for the Workers at Fukushima Daiichi Nuclear Power Station)," attached documents, May 31, 2012 [in Japanese].

Gray (Gy)
One Gray is the dose of kinetic energy absorbed by one kilogram of matter (absorbed dose). This unit is used to express the quantity of absorbed dose by any material.

Sievert (Sv)
The Sievert is a unit that reflects different types of radiation and the differences in the impact on the human body according to each particular organ or tissue area. It is possible to add these together. There are two kinds of measurement, known as the equivalent dose and the effective dose.

The equivalent dose is a value that takes into consideration the impact of the type of radiation; it is calculated from the absorbed dose. For alpha-ray radiation, 1 Gy is equivalent to 20Sv; for beta- and gamma-ray radiation, 1 Gy is equivalent to 1Sv.

The effective dose is the total of the equivalent dose on each organ and tissue area, and the value shows the entire body's exposure to radiation.

Counts per minute (cpm)
This is the number of atoms in a given quantity of radioactive material that are detected to have decayed in one minute. In order to assess the radiation exposure on the human body, this unit is generally converted to Sv.

4.2 Problems with evacuation orders from the residents' perspective

The Commission found that many residents were unaware that the accident had occurred; in some cases, they were still unaware of the accident at the time evacuation orders were issued.

As the accident progressed and damage from the accident began to worsen, the evacuation zones were frequently revised, forcing many residents to relocate multiple times. Many residents did not receive accurate information along with the evacuation orders, including news about the seriousness of the accident or the expected term of their evacuation.

The number of residents who were evacuated as a result of the government's orders totalled approximately 150,000. Unaware of the severity of the accident, they thought that they would be away from their homes for only a few days. They headed to the evacuation shelters literally with "just the clothes on their backs." Ultimately, however, they have been subjected to a long-term evacuation.

The evacuation zone, originally designated as an area within a 3km radius from the power plant, was expanded to a 10km radius, and then again to a 20km radius by the day following the accident. Each time the evacuation zone changed, the residents were forced to relocate to other evacuation shelters, increasing their stress. Some evacuees unknowingly evacuated to areas that were later found to have high doses of radiation. In the 20km zone, at least 60 hospital patients and elderly residents of long-term health care facilities died by the end of March due to difficulties in securing evacuation transportation and finding proper evacuation shelters.

On March 15, orders for sheltering were given to the residents in the zone between 20 and 30 km from the power plant. The term of the sheltering lasted longer than originally expected, and as a result, the lifelines came under pressure and the infrastructure collapsed. In response to this situation, on March 25, the government issued an advisory to the residents in the 20-to-30km radius zone for voluntary evacuation. Not only did the government provide little reference information for residents to make a decision, but it also forced each resident to decide for themselves whether or not to evacuate. The Commission must conclude that the government abandoned its responsibility to protect the lives and safety of the public.

From the environmental radiation monitoring and the graphic data constructed by the System for Prediction of Environment Emergency Dose Information (SPEEDI) released on

March 23, the government knew that residents in some areas outside the 30km radius zone may have been exposed to relatively high doses of radiation. Despite this, the government's Nuclear Emergency Response Headquarters (NERHQ) did not react quickly, and evacuation orders were delayed for approximately one month.

Due to the above problems with the evacuation process, frustration among the residents rapidly increased.

Many residents not only replied to the questions in our Commission's survey, but added comments. Written in empty spaces on the survey, on the backs of survey sheets, on reply envelopes and on pages enclosed with the survey response, these described in detail the extreme confusion at the time of the evacuations, their current hardships, and their requests regarding the future. The sentiments of these residents were strongly communicated to the Commission through these messages.

4.2.1 Delayed transmission of accident information

1. *Timing of the residents' realization that there had been an accident*

At 15:42 on March 11, TEPCO made a notification of the event's occurrence to the Minister of Economy, Trade and Industry, Fukushima Prefecture and the municipality in which the power plant was located, as stipulated in Article 10 of the Act on Special Measures Concerning Nuclear Emergency Preparedness. At 16:45 on the same day, TEPCO also provided a report on the escalation of the situation as stipulated in Article 15 of the same act. At 19:03 on the same day, the government issued a declaration of a nuclear emergency situation.[16] However, until the morning of March 12, when an evacuation order was issued for a 10km radius around the power plant, awareness among residents about the accident was generally low. Furthermore, even in areas where residents were forced to evacuate, there were significant differences in how quickly the accident information was disseminated, depending on the evacuation area's distance from the plant.

According to the survey of residents by this Commission,[17] even among the residents of the five municipalities in the vicinity of the power plant (Futaba Town, Okuma Town, Tomioka Town, Namie Town and Naraha Town), the proportion of residents who knew that an accident had occurred prior to the issuance of an evacuation order for those within a 10km radius, which was issued just before 06:00 on March 12, was only approximately 20 percent.

2. *Sources of information concerning the accident*

For many residents, the mass media, such as television news, was the source of information about the accident. According to the Commission's survey, approximately 40 percent of residents in Futaba Town and Naraha Town acquired information about the accident from the local governments and police service. In Minamisoma City, Kawamata Town and Iitate Village, only a little more than 10 percent of residents acquired information from these sources. More than half of the residents of Minamisoma City, Kawamata Town, Iitate Village, Kawauchi Village and Katsurao Village became aware of the accident through mass media sources such as television news.

[16] See 3.1.1 and 3.3.1.

[17] An overview of the survey of residents by this Commission is as follows:
Purpose of survey: Understanding the status of evacuation orders, the evacuations themselves, and explanations provided about the degree of danger at the nuclear power plant.
Methodology of survey and period of implementation: Postal questionnaire, implemented between March 15 and April 11, 2012.
Residents to whom questionnaire was sent: From among the residents who had evacuated from the 12 municipalities listed below that fell under evacuation zone designations (approximate total of 55,000 households), a total of 21,000 households were randomly selected, with a sampling from each municipality.
Municipalities falling under evacuation zone designations: Futaba Town, Okuma Town, Tomioka Town, Naraha Town, Namie Town, Hirono Town, Tamura City, Minamisoma City, Kawauchi Village, Katsurao Village, Kawamata Town, and Iitate Village.
No. of responses collected: 10,633 (response rate of approximately 50%).

Figure 4.2.1-1: Percentage of residents who were aware that the accident had occurred (100 percent: evacuated residents)

*Source:*Results from the Commission's residents' survey (same applies hereinafter) [18]*

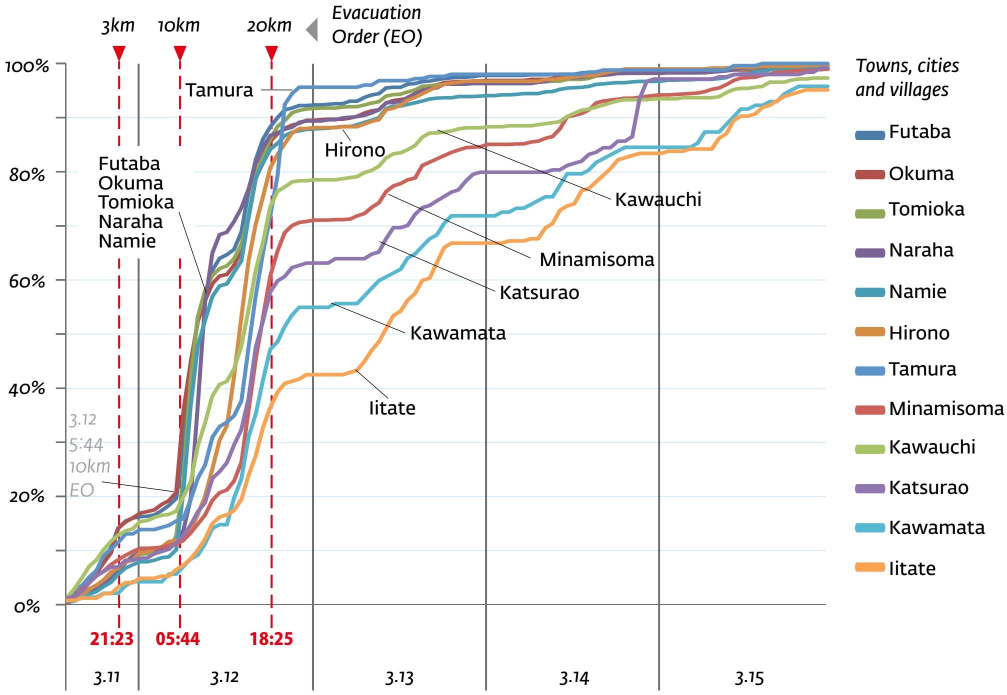
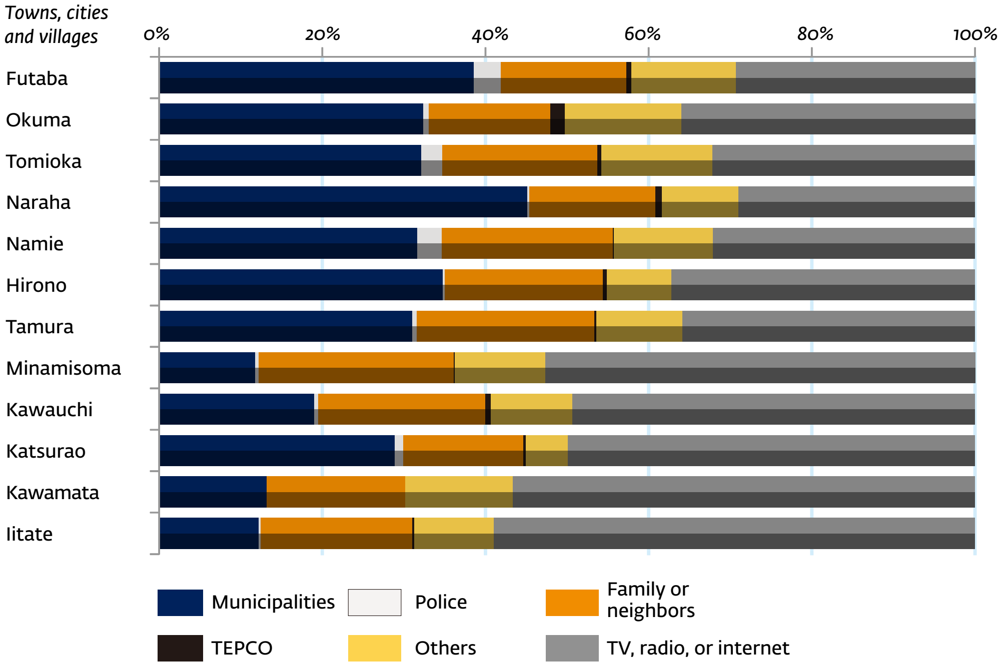


Figure 4.2.1-2: Source(s) of information concerning the accident [19]



[18] The parameters are the number of persons who responded "Yes" to Q4: "Did you evacuate due to the accident at Fukushima Daiichi Nuclear Power Plant?" and also inserted a time and date in response to Q2: "When did you know that there had been an accident at Fukushima Daiichi Nuclear Power Plant?" The parameters are as follows: Futaba Town: 861, Okuma Town: 993, Tomioka Town: 1,164, Naraha Town: 866, Namie Town: 1,297, Hirono Town: 608, Tamura City: 252, Minamisoma City: 1,159, Kawauchi Village: 521, Katsurao Village: 244, Kawamata Town: 142, Iitate Village: 247.

[19] The parameters are the number of responses to Q3: "What were your sources of information with regard to the accident at Fukushima Daiichi Nuclear Power Plant?" with multiple responses by single respondents all being counted. The parameters are as follows: Futaba Town: 1,119, Okuma Town: 1,342, Tomioka Town: 1,509, Naraha Town: 1,140, Namie Town: 1,714, Hirono Town: 828, Tamura City: 331, Minamisoma City: 1,839, Kawauchi Village: 793, Katsurao Village: 365, Kawamata Town: 265, Iitate Village: 441.

4.2.2 Problems with the actual evacuations from the residents' perspective

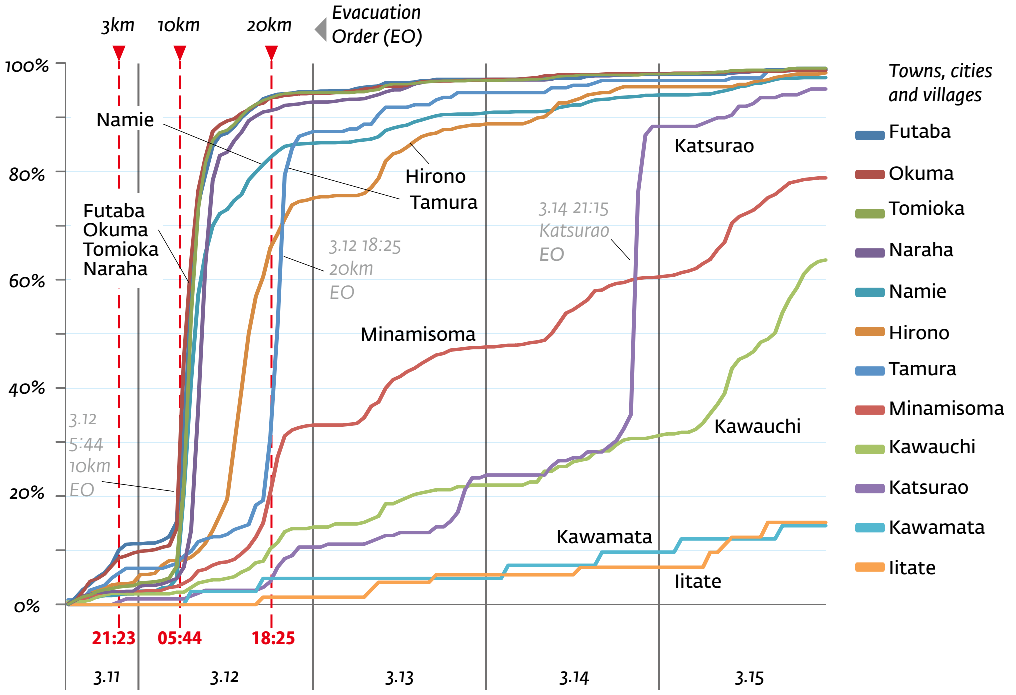
1. *Timing of when residents became aware of evacuation orders*

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.

Figure 4.2.2-1: Percentage of residents who had knowledge of the respective evacuation orders (100 percent: Residents who were evacuated) [20]



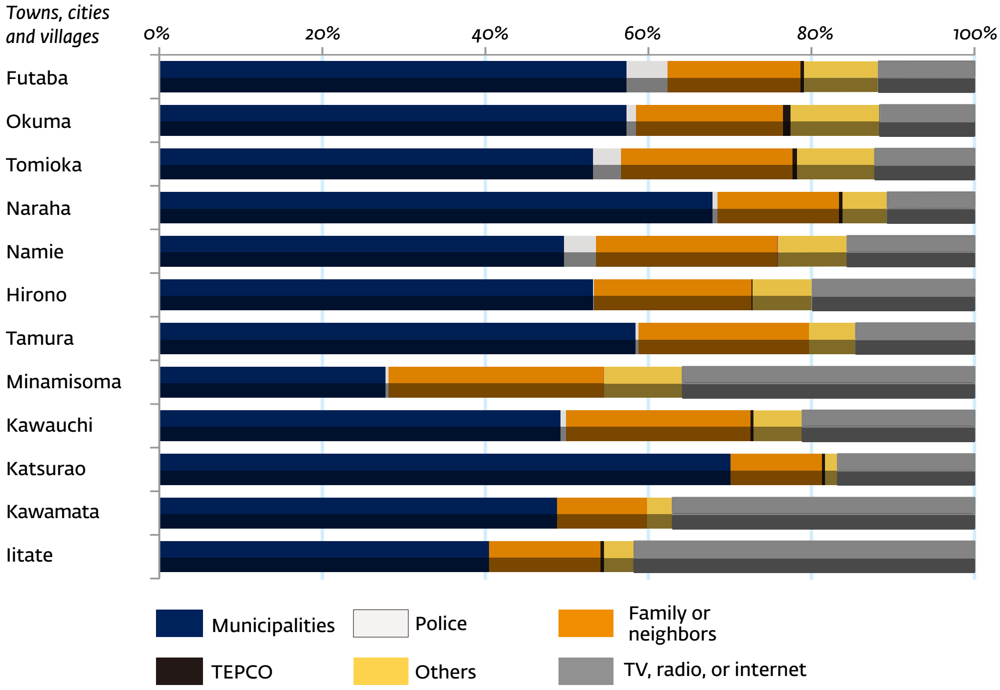
2. *Sources of information about the evacuation orders*

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

In Naraha Town and Katsurao Village, where the local governments had decided to

[20] The parameter is the number of respondents who filled in both date and time in Q7, "When did you learn about the evacuation order for the area that you were living in?," among respondents who answered "Yes" to Q4, "Did you evacuate as a result of the accident at Fukushima Daiichi Nuclear Power Plant?" The parameter is as follows: Futaba Town: 832, Okuma Town: 969, Tomioka Town: 1,128, Naraha Town: 805, Namie Town: 1,186, Hirono Town: 465, Tamura City: 222, Minamisoma City: 654, Kawauchi Village: 347, Katsurao Village: 187, Kawamata Town: 41. Iitate Village: 72. (*Due to the small sample sizes for Kawamata and Iitate, the figures have a low degree of reliability.)

Figure 4.2.2-2: Sources of information for evacuation orders [21]



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.

3. *Time of evacuation*

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

[21] The parameter is the number of responses to Q8, "What was the information source through which you first learned about the evacuation order?" In the event that one respondent selected multiple responses, each of the responses is counted. The parameter is as follows: Futaba Town: 1,053, Okuma Town: 1,264, Tomioka Town: 1,422, Naraha Town: 1,030, Namie Town: 1,519, Hirono Town: 672, Tamura City: 292, Minamisoma City: 1,266, Kawauchi Village: 577, Katsurao Village: 250, Kawamata Town: 127, Iitate Village: 242.

Table 4.2.2-1: Circumstances of evacuation for each municipality
[continued on the next page]

	Name of administrative district	Communication on accident to local governments	Communication of evacuation order from national/prefectural government to local governments			
			2km	3km	10km	20km
1	*Futaba Town*	*Received Article 15 notification: through Telephone communication from TEPCO (At about 16:36 on March 11)* [*1] *Two TEPCO personnel explained the situation (At about 17:00 on March 11)* [*2]	*Communication from the prefecture government* [*1]	*Communication from the national government* [*1]	*Communication from the prefecture government* *FAX from the national government (At 06:29 on March 12)*[*3]	--
2	*Okuma Town*	*Received Article 10 notification: through Telephone communication (Past 16:00 on March 11)* [*4] *Received Article 15 notification: through Telephone communication (At about 17:00 on March 11)*[*4] *Two TEPCO personnel explained the situation (At about 20:00 on March 11)* [*2]	*No communication* [*4]	*Learned through news reports* [*4]	*Verification sought from Okuma government to the prefecture government* [*2,4] *Telephone communication from Goshi Hosono (Special Advisor to PM) (At about 06:00 on March 12)*[*4]	--
3	*Tomioka Town*	*Received Article 10 and Article 15 notifications on Fukushima Daini* [*5] *Two TEPCO personnel explained the situation (At night on March 11)*[*2]	--	--	*Learned through news reports and emergency radio in Okuma Town*[*2,5]	--
4	*Naraha Town*	*Two TEPCO personnel of Fukushima Daini explained the situation (At about 22:30 on March 11)* [*2]	--	*Communication from the prefecture government and Fukushima Daini* [*7]	*Learned through news reports* [*7]	--
5	*Namie Town*	*Learned through news reports* [*8]	--	--	*Learned through news reports* [*8]	*No communication* [*8]
6	*Hirono Town*	*Received Article 10 and Article 15 notifications on Fukushima Daini* [*9] *Explanations of the situation by two TEPCO personnel of Fukushima Daini dispatched to the town* [*9] *Learned about Fukushima Daichi through news reports (At about 17:00 on March 11)*	--	--	--	*Learned through news reports* [*9]
7	*Tamura City*	*Learned through news reports* [*11]	--	--	--	*Communication from the prefecture government (March 12)* [*11]
8	*Minamisoma City*	*No communication* [*2]	--	--	--	*Learned through news reports* [*2]
9	*Kawauchi Village*	*Learned about the accident through request to receive evacuees from Tomioka Town mayor (morning of March 12)* [*12] *At about 10:00 on March 13 and 14:00 on March 14, Deputy plant manager of Fukushima Daini Nuclear Power Plant visited and explained the situation* [*12]	--	--	--	*Learned through news reports (Night of March 12)*[*12]
10	*Kasurao Village*	*Learned through reports* [*13]	--	--	--	*Learned through reports* [*13]
11	*Kawamata Town*	*Learned about the accident through request to receive evacuees from Futaba town mayo and Namie town mayor(March 12)* [*15]	--	--	--	*Learned through reports* [*13]
12	*Iitate Village*	*Learned through news reports* [*16]	--	--	--	*Learned through reports* [*13]

	Name of administrative district	See also further data on previous page	Evacuation order issued from local governments to residents	Evacuation details		Deliberate evacuation
				1st time	2nd time and after	
1	*Futaba Town*		*Evacuation order for all residents (07:30 on March 12)[*2]*	*Evacuation to Kawamata Town by bus, own vehicles, etc. (March 12)[*2]*	*Evacuation to Saitama Super Arena (March 19)[*2]* *Evacuation to former Kisai High School in Kazo City, Saitama Prefecture (March 30)[*2]*	--
2	*Okuma Town*		*Evacuation order for all residents (At about 06:21, on March 12)[*2]*	*Evacuation to Tamura City, Koriyama City, Miharu Town, Ono Town[*2,4]* *Bus (prepared by MLIT) (March 12. At about 06:30.)[*2]*	*Evacuation to Aizuwakamatsu, City (April 3)[*2,4]*	--
3	*Tomioka Town*		*Evacuation order for all residents issued by Tomioka Town government* *(Morning of March 12)[*5]*	*Evacuation of 6,000 people to Kawauchi Village by micro-bus (prepared by Kawauchi Village government) (March 12. At about 08:00)[*2, 5]*	*Evacuation to Big Palette Fukushima (March 16)[*2,5]*	--
4	*Naraha Town*		*Evacuation order for all residents issued by Naraha Town government (At 08:30, on March 12)[*2]*	*Evacuation to Iwaki City[*2, 7]* *Bus (prepared by Naraha Town and national governments) (March 12)*	*Evacuation to Aizumisato Town (March 16)[*2,7]*	--
5	*Namie Town*		*Evacuation order to area outside 10km radius, issued by Namie Town government (At 06:00, on March 12)[*8]* *Evacuation order to area outside 20km radius, issued by Namie Town government government (At 11:00, on March 12)[*8]*	*Evacuation to Tsushima district of Namie Town within town[*8]* *Bus (prepared by Namie town government) and own vehicles (March 12)*	*Evacuation to Nihonmatsu City (March 15)[*8]*	--
6	*Hirono Town*		*Call for voluntary evacuation to areas outside the town (Night of March 12)[*10]* *Evacuation order for all residents (At 11:00, on March 13)[*9,10]*	*Evacuation of all residents to Ono by bus (prepared by Hirono Town government) (March 14)[*9,10]*	--	--
7	*Tamura City*		*Evacuation order for all Miyakoji district residents, issued by the town government (March 12)[*11]*	*Evacuation order for all Miyakoji district residents to Funahiki district etc. (March 12)[*11]*	--	--
8	*Minamisoma City*		*Evacuation order for all residents within 20km radius (06:30 on March 1)[*2]*	*Evacuation to Fukushima, Prefecture Niigata Prefecture, Gunma Prefecture, etc.[*2]bus, own vehicles, etc.*	--	--
9	*Kawauchi Village*		*Evacuation order for all residents within 20km radius (March 13)* *Recommendation for voluntary evacuation (March 15)* *Evacuation order for all residents issued by Kawauchi Town government (March 16)[*12]*	*Residents within 20km radius evacuated to Kawauchi Elementary School (March 13)* *Evacuation to Koriyama City (March 16)[*12]*	--	--
10	*Kasurao Village*		*Evacuation order for all residents within 20km radius (March 12)* *Evacuation order for all residents issued by Katsurao Village government (At 21:15 on March 14)[*14]*	*Evacuation to Fukushima by bus (prepared by Katsurao Village government) (At 21:45 on March 14)[*14]*	*Evacuated to Aizubange Town (March 15)[*14]*	--
11	*Kawamata Town*		--	--	--	*Commencement of deliberate evacuation for residents of Yamakiya district (May 15)*
12	*Iitate Village*		--	*500 residents from high dose areas evacuated to Kanuma City of Tochigi Prefecture (March 19 to 20)[*16]*	--	*Commencement of deliberate evacuation (May 15)*

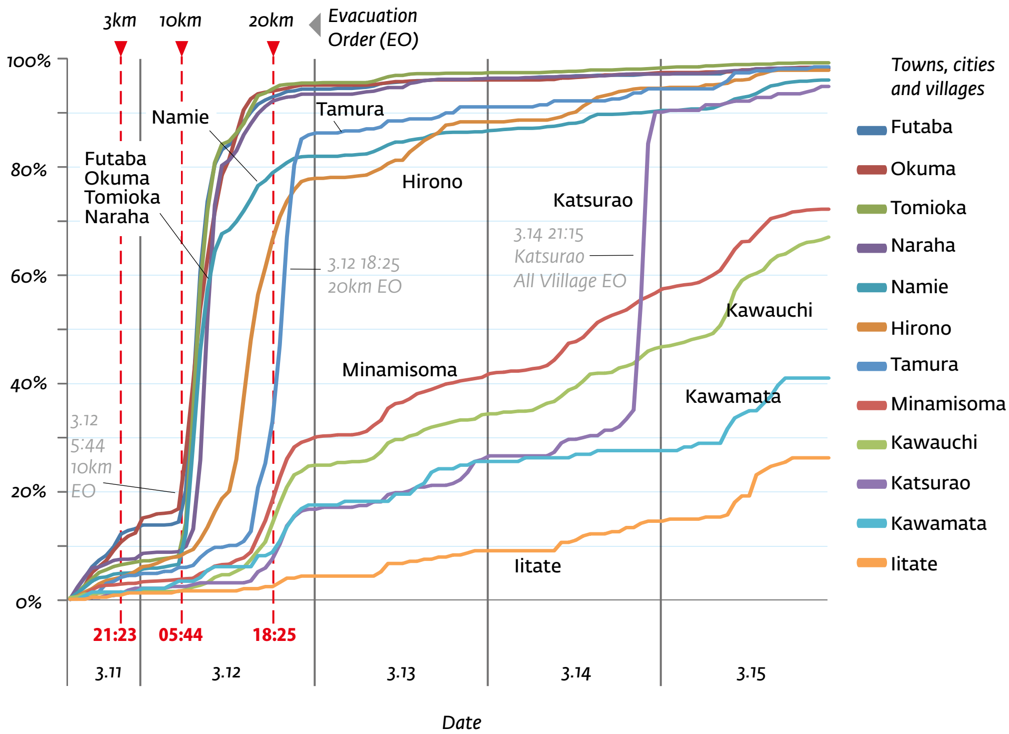
*1 NSC, 15th Emergency Preparedness Guide Working Group Reference Materials 2 "Hearing Survey on the Actual Conditions of Evacuation in Local Governments" (March 2011)
*2 All Japan Council of Local Governments with Atomic Power Station, Nuclear Disaster Review Working Group "Results of Survey on Local Governments Affected by Nuclear Disaster that Occurred as a Result of the Accident at Fukushima Daiichi Nuclear Power Plant" (March 2012)
*3 Katsutaka Idogawa, Futaba mayor, 3rd Committee of NAIIC
*4 Toshitsuna Watanabe, Okuma mayor, 11th Committee of NAIIC
*5 Hearing conducted on Tomioka
*6 Hearing conducted on Tomioka
*7 Hearing conducted on Naraha
*8 Tamotsu Baba, Namie mayor, 10th Committee of NAIIC
*9 Hearing conducted on Hirono
*10 Materials obtained from Hirono government
*11 Hearing conducted on Tamura
*12 Hearing conducted on Kawauchi
*13 Hearing conducted on Katsurao government
*14 Materials obtained from Katsurao
*15 Hearing conducted on Kawamata
*16 Hearing conducted on Iitate

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 [22]



4. *Evacuation with "little more than the clothes on their backs"*

a. Residents were evacuated while unaware of the nuclear accident

In the free-answer section of the survey, the Commission received numerous opinions and comments from residents—especially those in Futaba Town, Okuma Town, Tomioka Town, Namie Town, Naraha Town, Minamisoma City, and Hirono Town—

[22] The parameter is the number of respondents who input the date and time for Q11, "When did you actually begin to evacuate?,"among respondents who answer "Yes" to Q4, "Did you evacuate as a result of the accident at Fukushima Daiichi Nuclear Power Plant?" The parameter is as follows: Futaba Town: 894, Okuma Town: 1,068, Tomioka Town: 1,202, Naraha Town: 917, Namie Town: 1,368, Hirono Town: 660, Tamura City: 270, Minamisoma City: 1,380, Kawauchi Village: 612, Katsurao Village: 294, Kawamata Town: 149, and Iitate Village: 256.

to the effect that they had not received any information about the accident, they had been forced to evacuate with little more than the clothes on their backs, and they had not known their evacuation was due to a nuclear accident.

The following are sample quotes of some relevant opinions and comments from the residents.

A resident of Futaba Town

"I left my house with only the clothes on my back, with the intention of evacuating for a time. I found out where to evacuate from the emergency municipal radio communication system while I was on the road. I arrived at the first evacuation shelter after six hours in the car, instead of the one hour it takes under ordinary circumstances. On my way there, my son, who lives far away, told me by phone that I should not expect to return soon; and it was only then that I started to realize, gradually, what was actually happening. Can you understand what kind of life this is, to be displaced from your home and be separated from your friends and the people you know?"

A resident of Okuma Town

"If there had just been a word about the nuclear power plant when the evacuation order was issued, we could have made the minimal preparations; at the very least, we could have taken our valuables with us and locked up the house before evacuating. It is such a shock to us that we were forced to evacuate with nothing but the clothes we were wearing, and we find we've been robbed every time we are briefly allowed to return home."

A resident of Tomioka Town

"We would have preferred it if the government had stated that we would not be able to return for a while in their first evacuation order. I could not bring my valuables or, more importantly, the medical treatment records of my family with me. Since we did not have those records, I had a hard time sending my parents to a hospital during the evacuation, leading to a worsening of their medical conditions. It is hard for the elderly to have to flee with nothing but the clothes on their backs.

Although I have no attachment to Tomioka Town because we were only renting the house there before the accident, if we cannot continue to live in the temporary housing forever, we will have many other problems such as losing the roof over our heads and so on. I hope that welfare support will be reinstated. Because my father was not guided by staff from the prefectural government or the town hall during the evacuation, but rather by the medical service workers who usually took care of him, I could not receive any information from the local government staff about where my father had been evacuated, and thus it took me half a day to find him. It took too long for the local government to create a roster of evacuees."

A resident of Namie Town

"On the morning of March 12, I heard an announcement in the town gymnasium that we should evacuate to the Tsushima district because a tsunami was approaching Namie-Higashi Junior High School, not because a nuclear accident had occurred. I managed to spend the night at Tsushima Elementary School. If there had been concrete explanations about the occurrence of the accident then, I would have evacuated to a place further than Tsushima district. It was disappointing that information was not communicated to us."

A resident of Naraha Town

"The evacuation orders did not include any clear information about the nuclear accident, and were ambiguous. I think that evacuating without knowing the reasons behind the evacuation only contributed to greater anxiety among the people. Thereafter, distrust of the government and TEPCO grew, and the situation has remained unchanged, even now. However, its not a sense of dissatisfaction aimed at TEPCO employees, but rather a feeling that the deceptive corporate structure of TEPCO is unforgivable. Why did the accident happen? Did it first happen as a result of the earthquake, or because of the tsunami? Were there any parts of the post-accident response that were undisclosed or unreported? I would like the Commission to investigate the causes of the accident."

A resident of Odaka Ward, Minamisoma City

"Since we did not know that there had been a hydrogen explosion at the plant, we could not guess why we had to evacuate. The Fukushima Daiichi Nuclear Power Plant chief at the time of the accident recalled on TV that he thought he might die at the time, and that a possibility should have been instantly announced to the residents. In any event, information was released too slowly. It seems that the residents were toyed with."

A resident of Hirono Town

"I did not know that there had been an accident at the TEPCO Fukushima Daiichi Nuclear Power Plant, and so we heard the announcement from the town office calling for residents to evacuate without knowing why. Although I evacuated since I thought there was no electricity and water due to the earthquake and tsunami, I would have preferred being informed about the nuclear accident earlier. Now, I want to return home soon."

b. Evacuation order issued as a precautionary measure

In issuing the evacuation order for areas within a 3km radius of the Fukushima Daiichi Nuclear Power Plant and the shelter-in-place order for areas within a 10km radius of the same plant, Chief Cabinet Secretary Edano explained the situation at the time and the reasons for evacuating at a press conference held on the night of March 11:

"This order is a precautionary measure, and is an order to evacuate. Currently, there are no leakages of radioactivity outside the reactor. At this time, there is no danger to the environment."

On the morning of March 12, when an evacuation order was issued for areas within a 10km radius from the Fukushima Daiichi Nuclear Power Plant and a 3km radius of the Fukushima Daini Nuclear Power Plant, Chief Cabinet Secretary Edano gave a press conference. Given the facts that a venting operation order had been issued to TEPCO for reactors 1 and 2 of the Fukushima Daiichi Nuclear Power Plant, that the Article 15 notifications on respective reactors 1, 2, and 4 of the Fukushima Daini Nuclear Power Plant had been received, and that a Declaration of a Nuclear Emergency Situation concerning Fukushima Daini Nuclear Power Plant had been issued, Edano provided the following explanations for the evacuation order for (i) the areas lying within 10km of the Fukushima Daiichi plant, and (ii) for areas lying within 3km of the Fukushima Daini plant.

(i) "With regard to the release of radioactivity under these controlled conditions due to the venting order, please take note that ordering residents to evacuate to areas outside the 10km radius zone is only a measure taken to provide utmost assurance. And please evacuate in a calm manner."

(ii) "Similarly, with regard to the Fukushima Daini Nuclear Power Plant, as of this point, we have not confirmed any leakage of radioactive substances outside the reactor. As a precautionary measure, an evacuation order has been issued for residents living within a 3km radius of the Power Plant."

After the hydrogen explosion at Reactor 1 of the Fukushima Daiichi Nuclear Power Plant had occurred and the injection of seawater to the reactor had been implemented, when the evacuation order was issued for areas lying within a 20km radius of the Fukushima Daiichi Nuclear Power Plant, Chief Cabinet Secretary Edano explained the evacuation order at a press conference held on the night of March 12:

"Although, as with the response policies we have taken thus far, there is no actual danger to residents in areas lying between 10km and 20km from the plant due to the release of radioactivity, we have expanded the evacuation zone to 20km from the plant, considering the fact that new response measures may be taken, for the sake of taking full precautionary measures."

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.

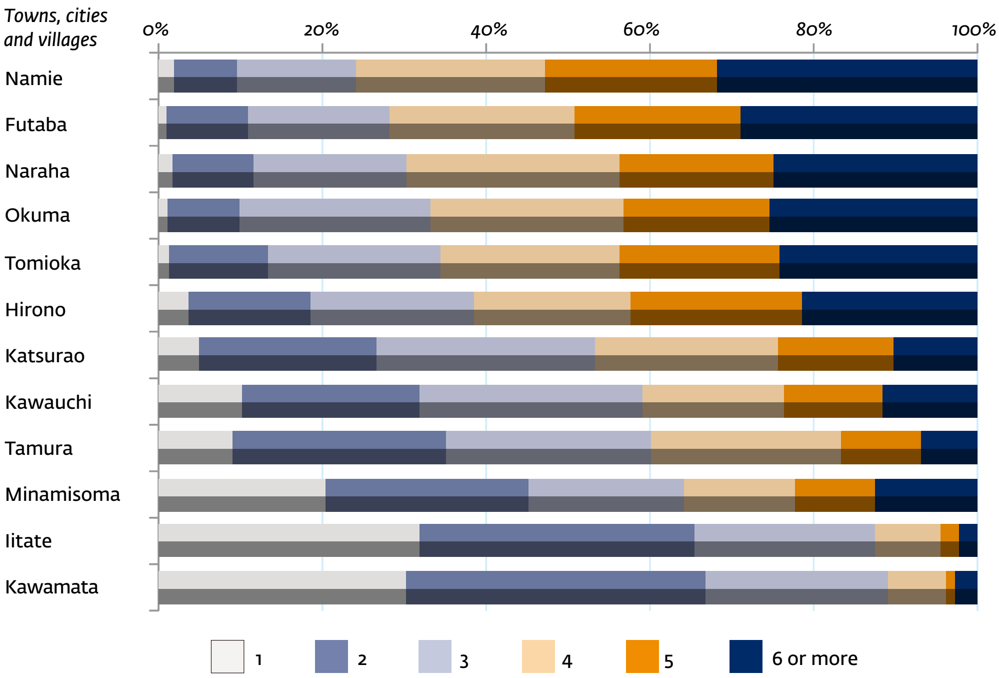
5. *Expansion of the evacuation zone and phased evacuation*

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. [23]

Figure 4.2.2-4: Number of times that evacuees from each municipality relocated during March 2012 [24]



[23] While the percentage of people who had evacuated more than six times had been the highest for Namie Town, amongst the responses from residents living in the same town, there was a stronger tendency to comment on evacuation to areas with high radioactive doses, and that SPEEDI information should have been disclosed immediately than comment on frequency of evacuation.

[24] The sample size was the number of respondents for Q13 "How many times have you evacuated to date?" The sample size is as follows: Futaba Town: 982, Okuma Town: 1,199, Tomioka Town: 1,353, Naraha Town: 1,022, Namie Town: 1,500, Hirono Town: 734, Tamura City: 286, Minamisoma City: 1,510, Kawauchi Village: 675, Katsurao Village: 317, Kawamata Town: 203, Iitate Village: 349.

A resident of Okuma Town

"A person in a white mask, who I am not sure was someone from the police or not, only told us to escape to the 'west,' and did not provide any specific instructions. Following these instructions, we headed toward Kawauchi Village; it usually takes around 30 minutes to get there, but it took us about five hours due to the traffic congestion. Upon arrival at Kawauchi Village, we found the roads, squares, and all other places jammed with cars, So we escaped to Katsurao Village, where we stayed one night. But the same night, this village was also designated as a part of an evacuation zone, so we needed to be relocated again. We were extremely worried, as we had our one-year old grandchild with us, and we still have worries even now. In evacuating from my hometown, I was concerned about finding hospitals that could provide dialysis treatment, since I have renal failure, but fortunately I was able to undergo dialysis in Koriyama. I heard that some patients were unable to receive dialysis treatment for about one week. I hope that hospitals can also be handled by national agencies."

A resident of Tomioka Town

"In accordance with the announcement to evacuate to Kawauchi Village, I headed there after making the necessary preparations, although I had no clue what was going on. But since the shelters in Kawauchi Village were full when we arrived, I had to find another shelter. When I arrived at Miharu sometime later, the shelters there were also full, so I was redirected to the shelter in Motomiya City. Even after that, I had to move several times, and I'm currently staying in a municipally subsidized rental residence in Iwaki City. One year has passed since then. We do not know what will happen to us."

A resident of Namie Town

"Every time I temporarily return to my home in Namie Town, I find that the roofing tiles have fallen off and radioactivity-contaminated rain falls in the house, leading me to feel that my home is not in a livable condition for my family. Every time I return home, I feel angry. My son says that it is impossible for us to live there anymore. On the evening of March 11, we were making plans for the next morning to repair and patch the roof of our home and prepared six blue sheets and a bundle of rope for that purpose [but] we were forced instead to head to Tsushima district and stay at the school for three or four days, as per the instructions from the emergency municipal radio communication system as well as the head of the community organization to evacuate immediately to the gymnasium or school in Tsushima district, an area which was later disclosed to have a high air dose rate. Since then, we have moved to six places within and outside of the prefecture before finally settling here, in Nihonmatsu City."

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.[25] 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

[25] Hearing with Haruki Madarame, NSC Chairman

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.[26]) 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-in-place 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 shelter-in-place orders were lifted on April 22. The areas subject to such shelter-in-place orders

[26] Areas lying within an 8km to 10km radius from the nuclear power plant, shown as "Genshiryoku Bosai Taisaku wo Jutenteki ni Jujitsu subeki Chiiki no Hani 'EPZ' no Meyasu (estimated range for zones that should be enhanced 'EPZ' with respect to measures for nuclear emergency preparedness)," under the Guide for Nuclear Emergency Preparedness issued by NSC [in Japanese].

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.[27]

The following are excerpts from the free response answers in the survey of residents living within a 20km to 30km radius, particularly from Minamisoma City,[28] pertaining to shelter-in-place orders (including opinions relating to the designation of an "Evacuation-Prepared Area in case of Emergency").

A resident of Minamisoma City (within the 20km to 30km radius)

"Even if I had wanted to evacuate, I could not do so because I have a parent who is suffering from dementia. Although evacuees continue to receive compensation as indemnity for the emotional distress they have gone through even now, those of us who sheltered inside our homes were compensated only once, and are now carrying out decontamination activities in the settlements. But didn't the people who sheltered indoors suffer the same emotional distress as the evacuees? It was reported that evacuees have moved to hotels or inns, continue to receive relief supplies, return home once a week, and have brought supplies from their homes. Meanwhile, having sheltered in our home, we are unable to purchase any essential goods because the stores are closed. We have also been unable to drive because there's no fuel. Should TEPCO give consideration to those who not only resided within a 20km radius but also those who had not evacuated from the previously designated 'Evacuation-Prepared Area in case of Emergency'?"

A resident of Minamisoma City (within the 20km to 30km radius)

"I had been living in the Baba district in Haramachi ward in Minamisoma City. The district was subject to shelter-in-place orders. However, at that time, it was extremely difficult to stay at home. This is because people had left town and food supplies (as well as fuel supplies) were diminishing. Therefore, we evacuated from the district based on our own judgment . . . (we are still living in evacuation shelters). Even after one year, I feel anger when I hear through the mass media about the true situation of the nuclear power plants at that time!! I think that the residents of Haramachi really suffered, since they did not receive any support, while those living in the restricted area have received numerous kinds of support!!"

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.[29]

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,[30] although it

[27] To stay indoors did not become prolonged for many residents in five municipalities: Naraha Town, where all residents had evacuated as of March 12; Hirono Town, which had issued orders to residents to evacuate voluntarily on the same day; Katsurao Village, which had decided to evacuate all its residents to Fukushima City by March 14; Namie Town, which had decided to evacuate all its residents to Nihonmatsu City by March 15; and Kawauchi Town, which had decided to evacuate all its residents to Koriyama City by March 16.

[28] With regard to staying indoors, Minamisoma City was selected as there had been many responses therefrom.

[29] NSC decision, "Genshiryoku Shisetsu-to no Bosai Taisaku ni tsuite (Emergency Preparedness for Nuclear Facilities)," June 30, 1980 [in Japanese].

[30] According to the stance taken by the International Commission on Radiological Protection (ICRP), as quoted in the Guide for Nuclear Emergency Preparedness, it is possible to avoid an effective dose of 5 to 50mSv by staying indoors for approximately two days. According to the stance taken by the International Atomic Energy Agency (IAEA), avoidance of an effective dose of 10mSv through a maximum expected stay indoors of two days is considered optimal. Source: the Guide for Nuclear Emergency Preparedness, Appendix 7. Japan Radioisotope Association, *Kokusai Hoshasen Bogo Iinkai no 2007nen Kankoku* (The 2007 Recommendations of the International Commission on Radiological Protection[ICRP]) (Maruzen, 2009) [in Japanese].

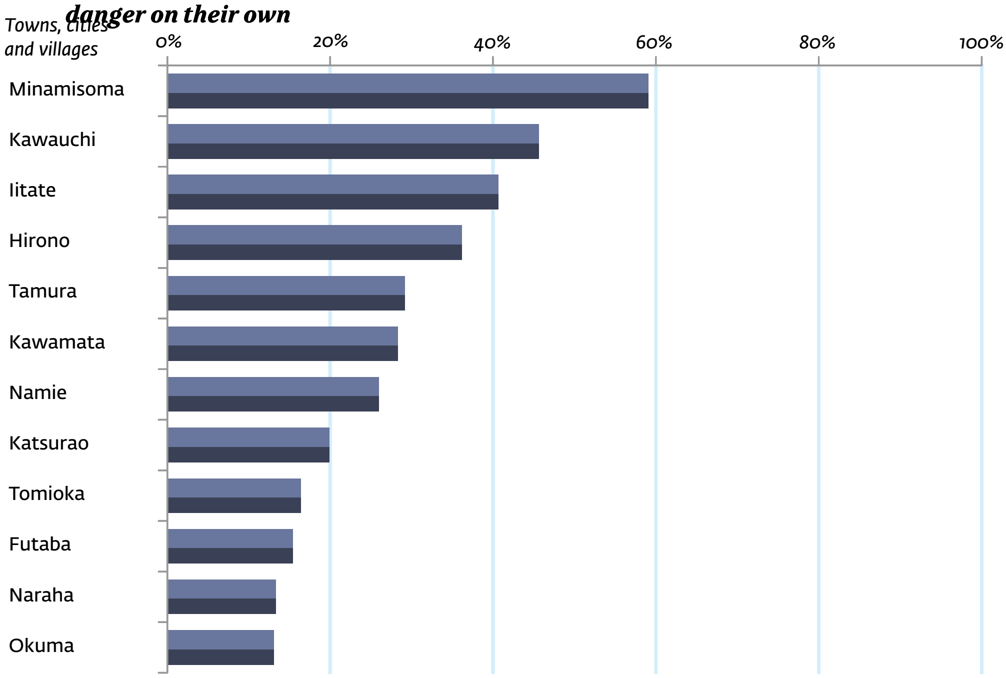
is not clearly stipulated in the Emergency Preparedness Guide. Since the Emergency Preparedness Guide was formulated with reference to the international consensus, the Emergency Preparedness Guide is in principle considered to be based upon a similar stance. [31]

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 shelter-in-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.[32] The attention and care given by the national government toward supporting the residents' lives was completely inadequate.

7. *Voluntary evacuation meant that residents were forced to assess the degree of danger on their own*

Figure 4.2.2-5: Percentage of residents who evacuated based on decisions made independently [33]



a. How did residents view voluntary evacuation?

On March 25, then Chief Cabinet Secretary, Yukio Edano announced at a press conference[34] that the national government had issued instructions to municipalities within the 20km to 30km radius zone from the nuclear power plants (i.e. the areas previously subject to shelter-in-place orders), encouraging the residents there to evacuate voluntarily.

[31] The estimated value established in the Guide for Nuclear Emergency Preparedness as an indicator for the issuance of orders to stay indoors is a predicted effective dose for external exposure (predicted dose in the event that no protective measures are taken) of 10mSv to 50mSv.

[32] NISA documents

[33] The sample size is the number of respondents for Q6: "Was the evacuation based on an order from the national or local government, or was it voluntary?" The sample size is as follows: Futaba Town: 909, Okuma Town: 1,129, Tomioka Town: 1,288, Naraha Town: 935, Namie Town: 1,317, Hirono Town: 594, Tamura City: 247, Minamisoma City: 1,090, Kawauchi Village: 484, Katsurao Village: 196, Kawamata Town: 106, Iitate Village: 192.

[34] Press Conference by then Chief Cabinet Secretary Yukio Edano (March 25, 2011)

Results of the survey conducted by the Commission showed that a large proportion of residents had already evacuated voluntarily from areas where the majority fell outside the 20km radius and evacuation orders from the national government had been issued relatively late, such as Minamisoma City, Kawauchi Village, Tamura City, Iitate Village and Kawamata town. [35]

The following are excerpts from the free response section of the survey of residents pertaining to voluntary evacuation. There was a particularly large number of responses from residents in Minamisoma City and Kawauchi Village.

A resident of Minamisoma City (within the 20km to 30km radius)

"It was difficult for us to decide whether or not to evacuate voluntarily, and if so, how to select a destination. Furthermore, since we had been instructed to shelter ourselves indoors and keep the windows closed after the nuclear accident, we were unable to hear any of the information that was broadcast by the municipal sound vehicle that patrolled the area about twice a day. Although we had not received news from any sources since we were living in the urban part of town, we heard from our relatives living outside the city that the head of the ward had told them to evacuate voluntarily. (text omitted) I felt very sad when I saw the attitude of TEPCO's executives on NHK broadcasts; they seemed not to feel any responsibility for the nuclear accident. I guess that one of the major reasons for the accident was the continued use of the nuclear power plants even after the expected lifetime of the plants had expired. This accident is not an "unanticipated" disaster. Lastly, my deepest concerns are about the future effects on our children."

A resident of Kawauchi Village (within the 20km to 30km radius)

"Immediately after I heard the first report about the accident on March 11, many people evacuated and relocated to our village. Young people used their mobile phones to send messages like chain mail, urging one another to "Evacuate!" However, we did not receive official information about the issuance of evacuation orders from any sources. The only order we received was the shelter-in-place order through the emergency municipal radio communication system. We evacuated voluntarily because we heard a person in the neighborhood whose family member was working for the police saying, "I am evacuating because it just seems dangerous somehow." We have heard that the police had already left Kawauchi Village by March 14. Volunteer workers who had been preparing meals at the outside soup kitchen in the village had used up the fuel moving around within the village. I wish that the government had given us help to evacuate earlier. I cannot help thinking that we have been let down."

b. Voluntary evacuation meant the government abandoned responsibility for securing people's lives and safety

NERHQ's encouragement of residents to voluntarily evacuate, communicated via the municipal governments, means that the decision to evacuate was relegated to the residents themselves.

In issuing the instruction encouraging voluntary evacuation, then Chief Cabinet Secretary Edano[36] explained that the reason the government issued the instruction to municipalities was that the shelter-in-place order had led to a difficult situation for residents to maintain their lives due to the halt of commerce and logistics; this was based upon the fact that there was no need to establish new evacuation zones because nothing had happened—such as a new release of radioactive materials—since the issuance of shelter-in-place orders.

From around this time, the secretariat of the NERHQ started providing not only living assistance to residents who sheltered indoors; it also provided Fukushima Prefecture with information about lodging facilities and transportation, and provided physical supplies to assist residents who had voluntarily evacuated. [37]

[35] In Hirono Town, residents had been encouraged to evacuate to areas outside the town on March 12, before Ono Town had been designated as their evacuation shelter on March 14. In addition, a decision was made on March 13 to evacuate all residents. These are considered to be the reasons for the large number of voluntary evacuees.

[36] Press Conference by then Chief Cabinet Secretary Yukio Edano (March 25, 2011)

[37] Nuclear and Industrial Safety Agency documents

However, the concept of "voluntary evacuation" created confusion among residents, as it was a new concept that had not been addressed in either the Emergency Preparedness Guide or Prefecture Regional Disaster Prevention Plan. It is the natural right of citizens to decide to evacuate from locations that are possibly contaminated with radioactive substances in order to safeguard their own health, so relegating the evacuation decision might seem like a decision that respects citizens' liberty. We must conclude, however, that relegating the evacuation decision to citizens was inappropriate. It is the endowed duty of democratic states to protect the lives and safety of citizens, as part of the social contract between citizens and the state. Particularly in emergency situations such as a nuclear disaster, it is the responsibility of the government to fulfill that duty. The government and the NERHQ tried to fulfill that duty by issuing compulsory evacuation orders and establishing, in phases, 3km, 10km, and 20km radius evacuation zones, and also later designating Deliberate Evacuation Area. Then the government instituted a completely different response for residents within the 20-to-30km radius zone by forcing them to assess the degree of risk caused by radioactive substances by themselves and to make the decision to evacuate on their own. If there was no change in the situation (such as new releases of nuclear substances), as indicated by Edano, it should have been possible either to lift the shelter-in-place order and take measures to prevent the stagnation of distribution and commerce, or to expand the evacuation zone from a 20km radius to 30km if evacuation from the area was necessary. Although the NERHQ had confirmed information on March 25 about the dose level of the area that would serve as the foundation for establishing on April 22 the Deliberate Evacuation Area, the NERHQ postponed any decision about recalling shelter-in-place orders or expanding the evacuation zones, leaving residents to make evacuation decisions on their own. We must conclude that the government and the NERHQ abandoned their duty to protect the lives and safety of the citizens.

8. *Evacuation to contaminated zones*

Following the nuclear power plant accident, the NERHQ established, in phases, concentric evacuation zones around the nuclear power plant. This is not necessarily an inappropriate measure, as the degree of contamination was unclear during the initial stages of the accident. In fact, concentric evacuation was the basic approach taken during the 2008 Nuclear Energy Disaster Prevention Drill.

However, radioactive contamination does not of course spread outward in a concentric circle; the actual spread of contamination is influenced by the weather, including the direction of the wind. There were cases in which some of the locations where residents had been temporarily evacuated were later discovered to be areas with relatively high doses of radiation.

a. Voices of residents who evacuated to areas with relatively high radiation

On March 12, Namie Town independently decided to evacuate residents living within a 20km radius zone to the Tsushima district, an area outside the 20km radius zone. The same day, Futaba Town decided to evacuate residents to Kawamata Town, in accordance with instructions received from Fukushima Prefecture. From March 15 onwards, Minamisoma City guided voluntary evacuees from the city in the direction of Iitate Village and Kawamata Town. All of these destinations, however, were later designated as part of the Deliberate Evacuation Area in case of Emergency, due to their high doses of radiation.

According to the Commission's survey, the ratio of residents that evacuated to areas later designated as the Restricted Area or the Deliberate Evacuation Area was approximately 50 percent from Namie Town, 30 percent from Futaba Town, and 25 percent from Tomioka Town. It was also revealed that in other municipalities as well, 10 to 15 percent of the evacuated residents evacuated to areas with high doses of radiation that would later be designated as part of an evacuation zone.

Although these residents evacuated with the intention of ensuring their safety, they later discovered that they had unknowingly been in an area with high doses of radiation, causing many of them to suffer psychological stress.

The disclosure of data from SPEEDI (System for Prediction of Environmental Emer-

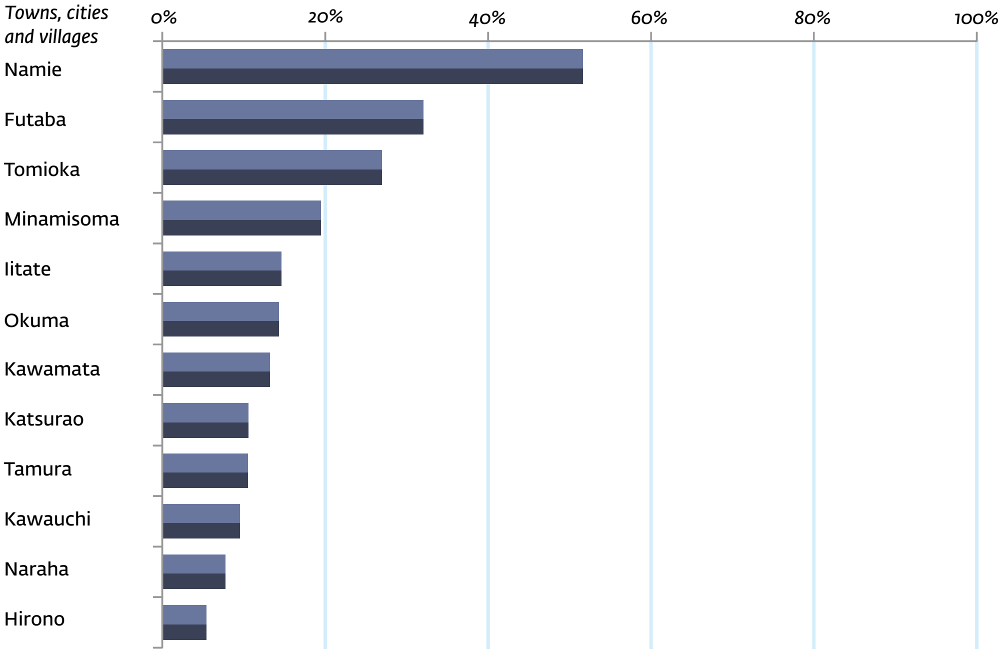


Figure 4.2.2-6: Ratio of residents who evacuated to areas that were later designated as restricted area or deliberate evacuation area [38]

gency Dose Information) is related the discussion about evacuation to the contaminated areas.[39] On March 23, the NSC released a diagram that expressed infant thyroid equivalent cumulative doses of iodine estimated by using SPEEDI with information on time-dependent radioactive source-term based upon data collected during emergency environmental monitoring. The diagram indicated the possibility that there were residents with iodine exposure surpassing a thyroid gland equivalent dose of 100 mSv in Iitate Village, Yamakiya district in Kawamata Town, and Tsushima and Akogi districts in Namie Town. This sparked criticism from residents in these areas that, if the Government had released the SPEEDI data more swiftly, they would not have been subjected to such unnecessary danger. The following are excerpts from their free responses to the survey.

A resident of Namie Town
"The fact that SPEEDI data was not immediately disclosed and that I therefore evacuated to a location with the highest air dose of radiation will pose a threat to my health for the rest of my life. Why did the Government not disclose the data? How much does the Government think a human life is worth? I am feeling uneasy about my future because my house is no longer livable, it will be difficult to develop the necessary infrastructure and decontaminate the area nearby, and there is also an interim nuclear waste storage facility nearby."

A resident of Namie Town
"I am left with feelings of tremendous disappointment and helplessness. This is because I think that the order to evacuate to Tsushima district, where air dose rates of radiation were high, would not have been issued to Namie residents had the prediction developed by the 12.8-billion yen SPEEDI system about dispersed radioactivity and information about the air dose rate of the area been properly communicated to the local government. I personally stayed in Tsushima from March 12 until the afternoon of March 15. I sincerely hope that nothing will be hidden, that the true causes for this incident are revealed, and that such an accident never occurs again."

A resident of Minamisoma City
"My wife was in the initial stages of her pregnancy at that time. If SPEEDI data had been disclosed sooner, our worry about health effects would have been lower. We moved

[38] The sample number is the number of respondents to Question 14: "Have you evacuated to a location later designated as restricted area or deliberate evacuation area?" The sample numbers are as follows: Futaba Town 935; Okuma Town 1,131; Tomioka Town 1,293; Naraha Town 984; Namie Town 1,439; Hirono Town 703; Tamura City 277; Minamisoma City 1,462; Kawauchi Village 647; Katsurao Village 300; Kawamata Town 182; Iitate Village 309.

[39] See 4.3.4 for more information.

from my home to my parents' house in Iitate Village, and then moved to Fukushima, where air dose rates of radiation were comparatively high. This is a great tragedy."

b. Misunderstanding incited by insufficient provision of data by the Government

As indicated above, the NSC released the diagrams calculated by using SPEEDI on March 23, 2011. After viewing the released diagrams, many residents of Namie Town, Minamisoma City, and Iitate Village voiced their criticism, realizing that, despite the fact that SPEEDI predicted the diffusion of radioactive substances, the belated release of diagrams calculated by SPEEDI caused them to evacuate to areas with high air dose rates and become exposed to radioactive substances.

However, the diagram released by the NSC on March 23, 2011 was a reconstruction of the past diffusion of radioactive substances, based upon inverse estimations of the source term, using actual measurements of radionuclide concentrations taken from emergency environmental monitoring. It is thus necessary to pay careful note to the fact that what the diagram showed was different from other diagrams and predictions of the diffusion of radioactive substances calculated by SPEEDI. Since the reconstruction of the past diffusion of radioactive substances conducted by the NSC was calculated to match the actual measurements of emergency environmental monitoring, it is natural that there be no disparity between the reconstruction that computes the diffusion of past radioactive substances and the actual measurement of emergency environmental monitoring.

More detailed information is provided later in 4.3.4, but the predictive calculation by SPEEDI is different from the results of the inverse estimations of source terms calculated by the NSC using SPEEDI Because the results of the inverse estimation did not exist when the Government issued its initial phases of evacuation orders and established evacuation zones on March 11 and 12. However, many residents misunderstood the message and believed that the diagrams showing inverse estimations of source terms that were created by the NSC using SPEEDI were SPEEDI's actual diffusion projections for radioactive substances. This caused many residents in Namie Town and other municipalities to think that the belated disclosure of SPEEDI data was the main problem behind the government's initial evacuation orders. This misunderstanding, which spread among residents, is further indication that the government's explanations to residents were inadequate.

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.

a. Voices of residents within Deliberate Evacuation Area

Responses to the free response section of the Survey conducted by the Commission showed that residents of Iitate Village and Kawamata Town particularly criticized the slowness in establishing the Deliberate Evacuation Area.

The survey showed that the ratio of residents of Iitate Village and Kawamata Town that had already evacuated by March 15 was less than 20 to 30 percent of the total amount number of evacuees of the village and the town, and thus there were large numbers of residents that remained in said municipalities as of March 15.[40] The following are excerpts from resident responses.

Residents of Iitate Village
"Since we lived in the area later designated as the Deliberate Evacuation Area, there was no evacuation order from the government at the time of the nuclear power plant accident. Therefore, my children and I walked around outside and were completely exposed to radioactive substances. I had made my youngest, at one year and six months old, carry on playing outside in tremendously high dose levels of radiation. Since the government knew the information from SPEEDI about dispersing radioactivity from an early stage of the accident, I wish that they had disclosed it. I don't understand how the government thinks. Life is important to us as well as the people in the upper positions, too, you know. The preciousness of children is the same for citizens as for people in the upper positions."

"We received absolutely no information about the initial stage of the nuclear power plant accident. We finally learned about the radiation after the IAEA came to conduct surveys on March 30. On television, Chief Cabinet Secretary Yukio Edano repeatedly announced that the air dose level of radiation was not a level that had an immediate impact on our health. This was nothing less than information manipulation. Iitate villagers were subject to radiation until April 22 (when Iitate was designated as the Deliberate Evacuation Area). Even though a year has passed since the accident, the government still whitewashes its actions by repeatedly revising the evacuation zones and not compensating us with any damages for our loss of property."

Residents of Kawamata Town
"The government kept saying that there was no immediate health risk, but they explained on April 16 that we needed to evacuate. We could have secured an evacuation shelter sooner if they had explained the situation of the plant and the diffusion of radioactivity to us sooner. I know that the disaster was widespread, but I still think that the response could have been faster. I felt that the government failed to assess the situation accurately during the initial stages of the accident, which is the most important part of responding to an accident, and that there were no instructions made for a unified response. I want the government to be ready for crises. Despite this being an unprecedented disaster, all I saw was partisan politics at play, leading me to doubt their character. It is disappointing that we as citizens are also responsible, since we chose them as leaders."

"An investigation of the accident is necessary, but I also think that a thorough investigation should be conducted into why residents were made to continue to live in locations with high air dose rates of radiation even though essentially they should have been evacuated. Why were we left unevacuated? Is the reason why residents in the Deliberate Evacuation Area were left unevacauated for a full month that the data from SPEEDI was not used? Please investigate why we are being forced to return home although the effects of decontamination efforts are not yet sufficiently proven."

b. The reason why the designation of the Deliberate Evacuation Area was delayed by one month
As indicated above, from data of the emergency environmental monitoring and the SPEEDI accumulation diagrams showing the estimation of infant thyroid equivalent doses of iodine, it is apparent that the NERHQ must have been aware of the high level dose rate of radiation around Iitate Village, Yamakiya district in Kawamata Town, and

[40] In addition, more so than the belated establishment of the deliberate evacuation area, residents from Minamisoma City expressed a large amount of criticism and dissatisfaction about the fact that there were no evacuation orders, but rather voluntary evacuations. Residents from Katsurao Village expressed less criticism and dissatisfaction about the evacuation orders than other municipalities. This can likely be attributed to satisfaction that the municipality government independently ordered an evacuation ahead of the National Government.

Tsushima district in Namie Town by March 23 at the latest. However, these areas were not designated as part of the Deliberate Evacuation Area until one month later, on April 22. Why was the designation of the Deliberate Evacuation Area delayed for so long?

The NERHQ must have been aware from around March 16, from the data of the emergency environmental monitoring, that there were areas with a relatively high level of air dose rate around Iitate Village and Tsushima District in Namie Town. The emergency environmental monitoring by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) recorded an air dose rate of between 255 μSv/h to 330 μSv/h around the Hirusone Tunnel in Namie Town between 20:40 and 20:50 on March 15; this information was released on the following day, March 16, by MEXT and at the press conference by Chief Cabinet Secretary Edano. At a later date, monitoring points near Akougi district in Namie Town and Nagadoro district in Iitate Village reported air dose rates surpassing 100 μSv/h, information that was also recognized by the Prime Minister's Office.

On March 21, the International Commission on Radiological Protection (ICRP) notified the Japanese Government that it should take measures based upon 2007 recommendations by the ICRP,[41] stipulating that, for the purpose of protection, reference levels for emergency exposure situations should be set in the band of 20mSv to 100 mSv effective dose.[42] On March 30, the IAEA also recommended that the Ministry of Foreign Affairs (MOFA) evacuate residents since one of the IAEA operational criteria for evacuation was exceeded in Iitate Village. [43]

However, new evacuation zones were not established until April 22.

The reasons behind the significant delay in establishing the Deliberate Evacuation Area are: 1) the time spent coordinating contradictory opinions between related organizations; and 2) the time spent discussing the criteria for determining the new evacuation zone.

Regarding the first reason, on March 21 the Fukushima Prefecture and Local Nuclear Emergency Response Headquarters (Local NERHQ) recommended that the Nuclear and Industrial Safety Agency (NISA) should make a careful decision about changing the area of evacuation zones. This was because "establishing evacuation zones in an enclave-like fashion would make residents anxious about the possibility of additional evacuation zones springing up in other locations, causing unnecessary confusion across the prefecture," and because "changing the zones of shelter-in-place and evacuation orders was assumed to cause confusion among residents, and thus a careful decision should be made by comprehensively taking into account all of the current factors."[44] On March 27, in an opinion exchange with the NERHQ, the mayor of Iitate Village also commented that expanding the evacuation zones would make residents wary, which would not be favorable.[45] As Iitate Village and Fukushima Prefecture did not wish to expand the evacuation zone, the NERHQ needed time to coordinate views with the related parties. While the NSC also commented on the necessity to consider revising the evacuation zone due to emergency environmental monitoring data from around March 18 that indicated specific local spots with comparatively high air dose rates, on March 20 the NSC rejected the need to consider revising the evacuation zone.[46] The approach of the NSC was so inconsistent in coordinating viewpoints that it was unable to fulfill its role as an advisory organization for the NERHQ.

Regarding the second reason, the NERHQ considered whether the reference levels prescribed in the ICRP Recommendation 2007 (Pub 103) should be adopted as criteria when determining the new evacuation zone, and, if they were to be adopted, how the specific criteria would be determined. In principle, the criteria used when deciding the evacuation zone is the level of the projected dose stipulated in the Emergency Preparedness Guide, which is either 50 mSv or more of external effective dose, or 500 mSv

[41] Japan Radioisotope Association, *Kokusai Hoshasen Bogo Iinkai no 2007nen Kankoku* (The 2007 Recommendations by the International Commission on Radiological Protection) (Maruzen, 2009) [in Japanese].

[42] NISA documents

[43] NISA documents

[44] NISA documents

[45] NISA documents

[46] NISA documents

or more of thyroid equivalent doses. According to this criteria, the 20-to-30km radius zone from the Plant and areas outside a radius of 30km with comparatively high air dose rates would not be deemed as exceeding standards stipulated in the Emergency Preparedness Guide, and NERHQ's issuance of the compulsory evacuation instruction would be neither justified nor optimised. On the other hand, the reference levels for emergency exposure situations created by the ICRP are in the band of 20 mSv to 100 mSv of effective dose, so if criteria were set based on the lowest value end of the band, issuing the compulsory evacuation instruction would be optimal. However, these considerations required time; ultimately, an integral dose of 20 mSv/year was adopted as the criteria for issuing evacuation orders.

As mentioned above, since the notification from the ICRP was already issued to the Japanese Government by March 21, it would have been possible for NERHQ to set the criteria subject to the ICRP reference levels for emergency exposure situations and then issue evacuation orders to residents in areas with high air dose rates, if NSC advice had been issued to NERHQ and a prompt decision by NERHQ had been made. Or, if any air dose rate had been set beforehand as an operational intervention level to indicate when an evacuation instruction should be issued, it would have been possible for NERHQ to automatically issue evacuation orders once the air dose rate in a particular area surpassed the level, eliminating the time spent determining new evacuation criteria.

Because it took time for NERHQ to coordinate the views and decide on the evacuation criteria, it was not until April 11 that NERHQ announced the establishment of Deliberate Evacuation Area, following the official advice[47] by the NSC, and not until April 22 that the actual Deliberate Evacuation Area was set.[48] This sort of confusion by NERHQ indicates that NERHQ did not have the safety of the country's citizens as its top priority.

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.[49] 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.

The "specific recommendation for evacuation" was designated household by household, in which residents of designated households had the choice to evacuate, making those who chose to evacuate eligible to receive assistance (compensation from TEPCO, exemption for medical insurance, national health insurance, pension and public nursing care insurance, etc.). As a result, some residents have commented that the household-based designation scheme has created gaps in the community,[50] and they have requested that compensation and assistance be provided to residents who did not evacuate as well, because they also experienced emotional trauma.[51] The NERHQ, however, has not responded to requests by residents to designate spots based upon areas rather than households, or to requests to provide compensation to those who did not evacuate.

In contrast, in Russia, Ukraine, and Belarus following the accident at the Chernobyl Nuclear Power Plant, the governments implemented evacuation measures in which residents living in areas with an effective dose of between 1 mSv and 5 mSv were granted the right to relocate by community, and both those who wished to relocate

[47] NSC, " 'Keikakuteki Hinan Kuiki' to 'Kinkyuji Hinan Junbi Kuiki' no Settei ni tsuite (The Establishment of Deliberate Evacuation Area and Emergency Prepared Area in case of Emergency)," April 10, 2011 [in Japanese].

[48] Press Conference by then Chief Cabinet Secretary Yukio Edano (April 11 and 22, 2011)

[49] NERHQ, "Jiko Hasseigo 1nenkan no Sekisan Senryo ga 20mSv wo Koeru to Suitei sareru Chiten no Taio ni tsuite (Response to areas assumed to have an annual accumulated radiation dosage of over 20 mSv following the nuclear power plant accident)," June 16, 2011 [in Japanese].

[50] Hearing with Date City residents

[51] NISA documents

and those who did not were granted public assistance (establishment of the "Zone of Guaranteed Voluntary Resettlement"). [52]

There was also dissatisfaction among Fukushima residents in relation to the disparity in criteria used between muncipalities to designate specific spots of recommended evacuation. For instance, even though 3.2μSv/h of air dose rate at a height of one meter (roughly 20 mSv/year in the dose of exposure) was, in theory, used as a criterion to designate specific spots of recommended evacuation in Date City, households that did not meet this criterion were still designated as specific spots of recommended evacuation after additional considerations of the circumstances of the community in which the households were located, and households with pregnant women and children that resided near other specific spots of recommended evacuation were also widely designated as spots. Minamisoma City independently set its own criterion for designating specific spots of recommended evacuation, as well as designating households with pregnant women and children located near other designated areas using a different criterion. Later, however, Minamisoma City applied its special criterion for pregnant women and children to all households. [53]

Meanwhile, there were two points in Fukushima City with levels of over 3.0 μSv/h, but Fukushima City indicated that it prioritized decontamination of those points, deferring designation of these spots as specific spots for evacuation because the residents did not express the desire to be evacuated. At a briefing session on whether to designate the specific spots for evacuation, residents in Fukushima City requested the city government to apply unique standards so that designations were made not only on a community basis but also for households with pregnant women; however, Fukushima City would not respond to these requests.[54] To sum up, the city did not take into account the opinions of residents and the real situations of communities, which means that the city government paid inadequate respect to the residents' rights to choose to evacuate or stay.

The following is an excerpt of opinions from Minamisoma City residents, as expressed in the free response section of the Commission survey.

Residents of Minamisoma City

"In the area where we live, some people evacuated in accordance with instructions by the government and others did not evacuate at all. I think that compensation for the psychological distress suffered as a result of the nuclear power plant accident should be fairly provided, not only to people who evacuated, but also to those who did not. Fair compensation should be provided to all the households designated as specific spots recommended for evacuation, including those who did not evacuate, because the individuals who did not evacuate still suffered mental distress from the closure of shops, the closure of hospitals, and the impossibility of eating vegetables they grew as a result of consciousness about radiation exposure following ingestion."

"The area where we live includes points designated as specific areas recommended for evacuation, but designation was made only on a household basis. That means, even if there are several households with an equal level of dose in our community, the households having children are designated as specific areas recommended for evacuation while those without children are not designated. Despite the fact that circumstances in our community are as mentioned above, even glass badges are not distributed to the residents. We are left abandoned. The severing of our community has literally become a reality. So, it creates a sense of guilt among the community, even though we are all victims. Give serious thought to the purpose of the designations. Even now, as of March 12, 2012, there are people who plan to move in to temporary housing or evacuation shelters."

[52] The House of Representatives, "Cherunobuiri Genshiryoku Hatsudensho Jiko-to Chosa Giindan Hokokusho (Report by Parliamentary Survey Delegation on the Incident at Chernobyl Nuclear Power Plant)," December 2011 [in Japanese].

[53] NISA documents

[54] Fukushima City, "Watari, Ogura Chiku no Hoshasenryo Shosai Chosa Kekka-to ni kakaru Setsumeikai no Kekka ni tsuite (Results of the briefing session on comprehensive survey results of radiation doses in Watari and Ogura districts)," October 8, 2011 [in Japanese].

4.2.3 Evacuation of all hospital patients

Immediately after the accident, people who had difficulty evacuating—such as hospitalized patients[55]—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.

This section covers the evacuation of hospitalized patients from hospitals in the evacuation zone and then review the roles played by Fukushima Prefecture, the municipalities, and the hospitals in the evacuation of the hospitalized patients, focusing mainly on problems in the Prefecture Regional Disaster Prevention Plan.

1. *Reality of evacuation*

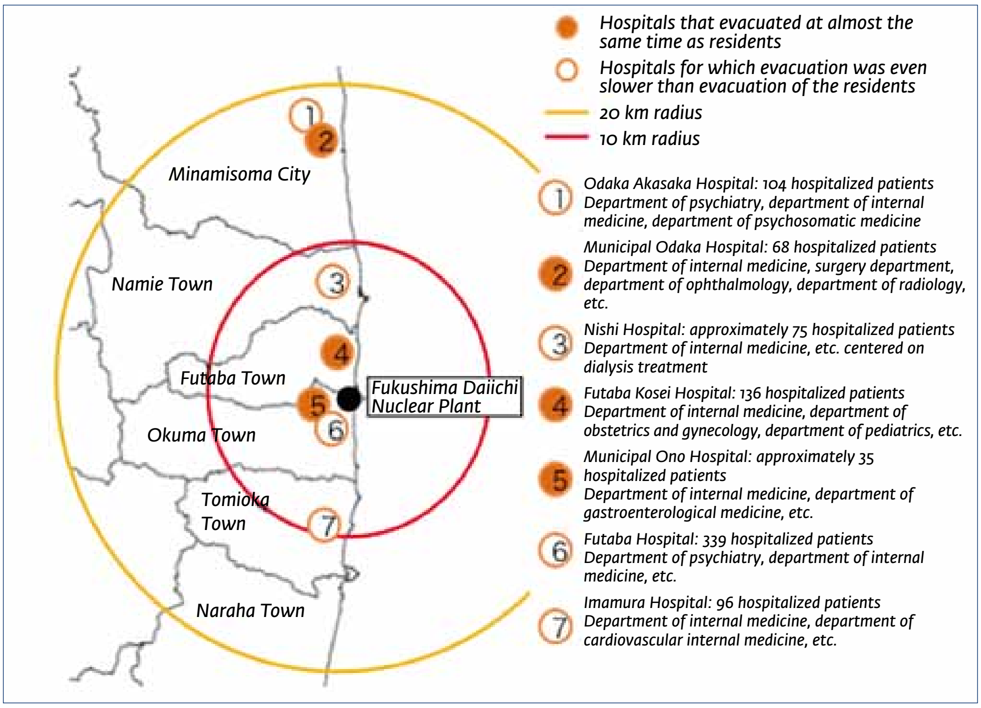
a. Overview of the medical institutions in the vicinity of the nuclear power plant when the accident occurred

There are seven hospitals inside the 20km radius zone from Fukushima Daiichi Nuclear Power Plant. They are located in five towns and one city: Okuma Town, Futaba Town, Tomioka Town, Namie Town, and Minamisoma City. More specifically, Fukushima Prefectural Ono Hospital (Okuma Town), Futaba Hospital (Okuma Town), and Futaba Kosei Hospital (Futaba Town) are within the 5km radius from the Plant; Imamura Hospital (Tomioka Town) and Nishi Hospital (Namie Town) are within the 10km radius from the Plant; and Minamisoma Municipal Odaka Hospital and Odaka Akasaka Hospital (both in Minamisoma City) are inside the 20km radius from the Plant. At the time of the accident, a total of approximately 850 patients were hospitalized at these seven institutions (see Figure 4.2.3-1). Among these patients, approximately 400 were seriously ill, who either had serious medical conditions, such as those requiring regular artificial dialysis or the regular suction removal of phlegm, or were bedridden.

When the evacuation orders were issued in a phased manner in response to the accident, responsibility for the patients in these hospitals was left by the neighborhood residents and the local governments, with the result that each hospital had to secure means of evacuation and shelters for the hospitalized patients on its own (see Reference Material [in Japanese] 4.2.3-1).

[55] "Hospitals" as defined in the Medical Care Act, Article 1-5 refers to "a place where doctors or dentists practice medicine or dentistry for the general public or a specific large number of people, which possesses a facility for the hospitalization of 20 or more patients."

Figure 4.2.3-1: Overview of the hospitals within the 20km zone from Fukushima Daiichi Nuclear Power Plant when the disaster occurred



b. The sixty lives that could not be saved

According to our investigation, at least 60 people died in the seven hospitals and in long-term care health facilities by the end of March 2011. The numbers of hospitalized patients who died between "the time after the earthquake and before the evacuation" and the "completion of transferring the hospitalized patients to different hospitals" were thirty-eight from Futaba Hospital, four from Futaba Kosei Hospital, three from Imamura Hospital, and three from Nishi Hospital.[56] The people admitted to the long-term care health facility affiliated with Futaba Hospital evacuated together with the hospitalized patients in Futaba Hospital, ten of whom died. More than half of the deceased people were elderly people 65 years or older. It is apparent that Futaba Hospital, where more than 40 people died by the end of March 2011, experienced the severest evacuation situation, since it was relatively slow to secure evacuation shelters with medical equipment and transportation for evacuation; in addition it had a large number of hospitalized patients.

c. Differences among hospitals in the burdens on patients

Among the seven hospitals within a 20km radius from the Plant, there were large differences of degree in the burdens on patients, depending upon whether or not the hospitals could secure medical institutions as evacuation shelters or a means of evacuation.[57]

Fukushima Prefectural Ono Hospital, Futaba Kosei Hospital, and Minamisoma Municipal Odaka Hospital were able to secure means of evacuation and medical institutions as evacuation shelters early on, and all of their hospitalized patients were evacuated by March 13, almost the same time as the evacuation of the neighborhood residents. None of the patients in Fukushima Prefectural Ono Hospital or Minamisoma Municipal Odaka Hospital died. There were four deaths in Futaba Kosei Hospital, but they were all judged to be deaths from disease unrelated to the stress of the evacuation

On the other hand, Imamura Hospital, Nishi Hospital, Odaka Akasaka Hospital and Futaba Hospital struggled to secure medical institutions as evacuation shelters and means of evacuation. These four hospitals were so much slower to evacuate than the neighborhood residents and local governments that their situation became critical. Issues common to the four hospitals include manpower shortages caused by the evacuation of medical professionals, evacuation of seriously ill patients by bus, and

[56] Here we do not discuss whether or not the death of each hospitalized patient was directly caused by the evacuation.

[57] Hearing with hospital staff

Name of hospital	Methods of arranging the means of evacuation for seriously-ill patients	Date of evacuation of seriously-ill patients	Method of evacuation of seriously-ill patients	Primary evacuation destination of seriously-ill patients	Number of fatalities by the end of March
Municipal Ono	*On the morning of the 12th, made requests to OFC for buses and to the fire department for ambulances.*	*Morning of the 12th*	*Ambulances*	*Comprehensive Health, Welfare and Medical Care Facility in Kawauchi Village*	*0*
Futaba Kosei	*On the 12th, a doctor at Fukushima Medical University Hospital made contact and arranged Japan Self-Defence Forces helicopters.*	*Night of the 12th to morning of the 13th*	*Japan Self-Defence Forces helicopters*	*Fukushima Gender Equality Center in Nihonmatsu City Camp Kasuminome near Sendai City*	*4*
Municipal Odaka	*On the 12th they asked for assistance from the fire department and arranged ambulances. The employees prepared microbuses for patient evacuation.*	*13th*	*Ambulances Microbuses*	*Minamisoma City Municipal Hospital*	*0*
Imamura	*On the 12th appealed to the Fukushima Prefecture for assistance. Furthermore, requested assistance from the police through a police officer who was hospitalized there at the time.*	*Night of the 13th to dawn on the 14th*	*Japan Self-Defence Forces helicopters*	*A high school in Koriyama City*	*3*
Nishi	*On the 12th the town office and the police prepared buses but they were not suitable for the symptoms of the patients so this idea was abandoned. They waited until the 14th for Japan Self-Defence Forces helicopters and some of the patients evacuated in police vehicles.*	*Night of the 14th*	*Japan Self-Defence Forces helicopters Police vehicles*	*Fukushima Medical University Hospital, etc.*	*3*
Odaka Akasaka	*On the 12th and 13th they asked the district office for assistance but received none. The police who came to the hospital on the 14th arranged buses that evening.*	*Night of the 14th*	*Buses*	*A high school in Iwaki City*	*0*
Futaba	*There was no assistance for the seriously-ill patients from the town office, and from the 12th they asked the fire department, police, and Japan Self-Defence Forces for assistance but buses and Japan Self-Defence Forces vehicles for transporting the seriously-ill patients arrived on the 14th and 15th.*	*14th to 15th*	*Buses Japan Self-Defence Forces vehicles*	*A high school in Iwaki City Fukushima Gender Equality Center in Nihonmatsu City, etc.*	*40*

Figure 4.2.3-2: Evacuation timing, transportation methods and no. of fatalities [58]

transport of the patients to evacuation shelters with no medical equipment, which led to the aggravation of many patients' poor physical condition and the deaths of some patients. (See Figure 4.2.3-2.)

2. *Factors leading to critical situations*

The evacuation of hospitalized patients from the hospitals in response to the accident imposed an excessive burden on the patients, due to the following factors that are unique to a nuclear disaster.

a. The nurses and other medical staff evacuated, resulting in a shortage of medical professionals in the hospitals.

b. The transportation infrastructure came under strain and means for evacuations of hospitalized patients were limited; the large evacuation zone meant that lots of residents in the vicinity also needed evacuation transportation.

c. The evacuation zone covered a large area, making the hospitalized patients evacu-

[58] We excluded the cars and other vehicles of employees used to transport a small number of patients. The figure is compiled by NAIIC based on hearing with staff of the hospitals.

ate over long distances and for long periods of time.

d. There was a need to secure evacuation shelters within a short period of time in order to avoid exposure to radiation, so some of the hospitals initially evacuated to shelters that did not have sufficient medical equipment.

a. Shortages of medical professionals

Immediately after the accident, medical professionals, including nurses, left the hospitals during the early phases of evacuation because the intermittent hydrogen explosions in Fukushima Daiichi Nuclear Power Plant made them fear the effects of radiation. There were shortages in the number of medical professionals to help the hospitalized patients who were left behind in the evacuation zone, giving rise to a situation where there were limited numbers of lifelines or medical supplies and resulting in insufficient provision of medical treatment and nursing care.

In the case of Nishi Hospital, for example, there was panic in the hospital following the hydrogen explosion of Unit 1. On the afternoon of March 12, 17 nurses, who were worried about their families, told the hospital director that they wanted to leave the workplace. As a result, the number of nurses at the hospital became zero at one time. The evacuation of the hospitalized patients was later carried out by the town pharmacist, some nurses who returned to the hospital after confirming that their families were safe, and others.

In the case of Imamura Hospital, most of the hospital employees accompanied slightly ill patients to evacuate to Kawauchi Village, leaving 67 seriously ill patients and eight hospital employees behind.

At Futaba Hospital, three separate stages of evacuation were carried out over the period from the 12th to the 15th. At the time of the first evacuation on the 12th, when the slightly ill and ambulatory hospitalized patients were transported out of the hospital, all of the nurses, doctors and other employees in the hospital went with them, leaving behind only one hospital director. One hundred twenty-nine seriously ill patients were left behind in the hospital,[59] to whom only six medical professionals at most, including the employees of the adjacent long-term care health facility affiliated with Futaba Hospital and the doctors who returned to the hospital, provided medical treatment and nursing care over the three days it took to complete the evacuation. There were shortages of both daily commodities and medical supplies, and they only had candles for lighting. Although the doctors provided the best possible medical treatment they could at that time, four patients died in the hospital by March 15, 2011.

In our interviews with personnel of Nishi Hospital, Imamura Hospital, and Futaba Hospital, one interviewee said, “we wanted the medical staff to remain in the hospital, but I did not feel we could strongly insist that they stay because I knew they had concerns about radiation and the employees also had families.” The interviewee said further, “we expected that even if the number of medical staff was reduced, aid from public agencies would come immediately. So we thought that we would be able to hang on with a small number of people.”[60]

b. Limited means of evacuation and rescue

At the time of the accident, evacuation orders were issued to many residents, putting the transportation infrastructure under strain; the means of evacuation for use by medical institutions were extremely limited.

The biggest problem faced by each hospital was the transport of seriously ill patients. For example, Nishi Hospital received an offer of a 20-seater bus from the prefectural police on March 12. But the hospital director declined the offer, judging that transferring hospitalized patients by bus would be difficult: if they were transporting seriously ill patients, such as patients with physical paralysis or on intravenous drips, only five or six patients would be able to ride on that bus at one time, and the physical

[59] Hearing with hospital staff

[60] A hospital staff said that “When the first group evacuated they also told the employees of Okuma Town village hall that the hospital director and some patients still remained behind so we thought that rescue vehicles would come immediately.”

burden riding the bus would impose on the patients would also be serious. [61]

Since it was necessary to use transporation such as ambulances and Japan Self-Defence Forces (SDF) helicopters, etc., which can convey medical instruments and impose little burden on patients, it was difficult to transport a large number of seriously ill patients.

c. Evacuations over long distances and long periods of time

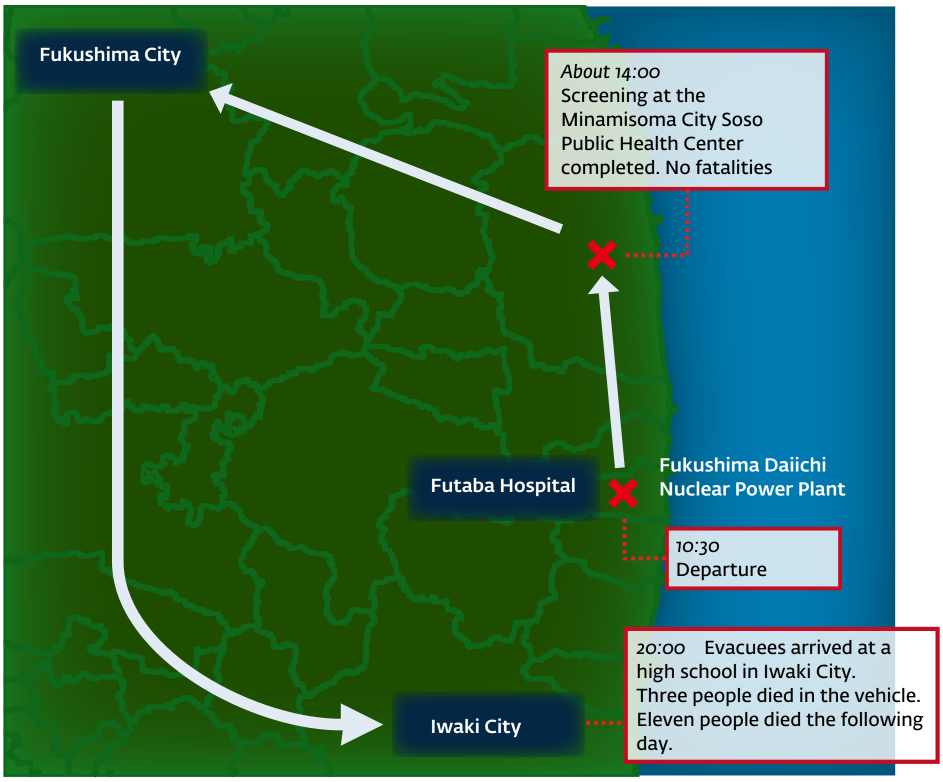
As a result of the accident, the patients were moved over long distances and for long periods of time.

For example, the hospitalized patients of Futaba Hospital were forced to relocate over a long distance (approximately 230km) and over a long period of time (over ten hours), with the result that some patients lost their physical strength and others died. At 10:30 on March 14, 2011, a total of 132 patients, including 98 patients remaining in the adjacent long-term care health facility and 34 seriously ill patients for whom it was judged that removal of their intravenous drips would not be life-threatening, departed from the hospital in large buses and other vehicles arranged by the SDF. They went temporarily to a public health center in Minamisoma City to undergo screening tests, while the Fukushima Prefecture Headquarters for Disaster Control (FHDC) searched for a hospital to act as an evacuation shelter. But since FHDC could not find an appropriate site,[62] at 20:00 the patients finally arrived at a high school in Iwaki City, the decided-upon evacuation shelter. Three patients died in the vehicles during the evacuation and an additional 11 patients died at the high school by early morning the following day (refer to Figure 4.2.3-3).

The same kind of situation occurred in the case of Odaka Akasaka Hospital.[63] This hospital evacuated its seriously ill patients to the gymnasium of a school in Iwaki City using a tourist bus on the afternoon of the 14th, resulting in a trip of nine-and-a-half hours over 200km.

Figure 4.2.3-3: Evacuation route from Futaba Hospital

Evacuation of 34 seriously-ill patients at Futaba Hospital and 98 users of the assisted-living facility by bus on March 14



[61] Hearing with hospital staff

[62] Hearing with the Fukushima Prefecture Headquarters for Disaster Control

[63] Hearing with hospital staff

d. Ensuring primary evacuation shelters

In order to minimize the damage caused by exposure to radioactive materials, the hospitals in the evacuation zone were forced to evacuate hospitalized patients with little time to decide which medical institutions should be their destinations. In particular, Odaka Akasaka Hospital and Futaba Hospital were initially forced to evacuate seriously ill patients to gymnasiums and other places that lacked medical equipment. At the time the evacuation began they had not even been informed of their destination.

At most of these seven hospitals, the hospital employees themselves had to search for medical institutions as secondary shelters to which patients could be transferred from the primary evacuation shelters.

In the case of Imamura Hospital,[64] after the primary evacuation to a gymnasium with no medical equipment had been completed, personnel called the FHDC on March 15 to ask which medical institutions could be used as secondary shelters; they were instructed: "please find them yourself." They were forced to telephone acquaintances of hospital doctors to find secondary shelters, but were mostly either turned down or received consent to use the medical institution's space only on condition they would bring nurses and helpers with them. This was because those hospitals were also suffering personnel shortages. Transferral of the patients to different hospitals was finally completed on the 17th. As a result, clear aggravation of the physical conditions of the seriously-ill patients, including fever and hypoxemia, was observed during the prolonged waiting time in the gymnasium.

In the case of Futaba Hospital, although the FHDC handled some of the arrangements in finding secondary, tertiary, or later shelters, the majority of the arrangements were made by the hospital staff themselves. Because there were few hospitals that could hospitalize large numbers of patients at once, the Futaba Hospital staff were forced to transfer a few patients at a time to different hospitals within and outside the prefecture. Patients were sent to a total of 90 hospitals in the end.

3. *Verification of the roles played by local governments and medical institutions*

Despite the fact that the hospitals in the evacuation zone suffered from critical situations during the implementation of the evacuations, Fukushima Prefecture and the municipalities did not actively provide assistance for the evacuation of seriously ill, hospitalized patients. The hospitals were forced to arrange the evacuations of all patients single-handedly, given that they could neither expect assistance from the government nor acquire sufficient information. As a result, the patients in hospitals that could not secure appropriate evacuation shelters and evacuation transport were forced to bear an excessive burden.

a. The role played by the FHDC

As stated above, the FHDC instructed hospitals to evacuate to shelters without medical equipment as the primary shelters, and did not provide sufficient assistance in finding medical institutions as later evacuation shelters. That means many hospitals were forced to secure their own evacuation shelters. In evacuation shelters without medical equipment, seriously ill patients were not able to receive sufficient medical care, leading to the deterioration of some patients' physical conditions.

Furthermore, the Rescue Squad in the FHDC was not actively involved in the response immediately after the accident. In interviews the Commission conducted with personnel of the Rescue Squad, they described the situation of the evacuations of hospitalized patients as follows: "I happened to notice that the SDF had already been working on the evacuation of Futaba Kosei Hospital"; "since we received an instruction from the Cabinet Office saying, 'Assist the evacuation of the hospitals inside the Restricted Area. Hurry up!,' we communicated the message directly to the SDF on standby in the FHDC."[65] From those comments, we can deduce that the prefecture was not proactively involved in the evacuation of hospitalized patients. [66]

[64] Hearing with hospital staff

[65] Hearing with the Rescue Squad in the Fukushima Prefecture Headquarters for Disaster Control

[66] It is reported that the Rescue Squad in the Fukushima Prefecture Headquarters for Disaster Control telephoned the hospitals in the prefecture to confirm which hospital can accept the evacuee patients. The information is from hearing with the Rescue Squad in the Fukushima Prefecture Headquarters for Disaster Control.

b. The role played by municipalities

The municipalities in which the hospitals were located were also not actively involved in evacuating all the hospitalized patients from the hospitals. Despite the fact that most of these municipalities knew the situation of the hospitals, they prioritized the transfer of governmental offices over the evacuation of the hospitals.

The Prefecture Regional Disaster Prevention Plan[67] stipulates, in relation to the evacuation of hospitalized patients in the municipalities, as follows: "The relevant municipalities shall give sufficient consideration to those who qualify as a so-called "Person Requiring Support Under Disaster Situation," such as the elderly, infants, expectant and nursing mothers, injured or sick persons, persons (children) with disabilities, and foreign nationals, etc. in relation to the provision of information, evacuation guidance, and life in the evacuation shelters. In particular, the relevant municipalities shall endeavor to ascertain the state of health of a Person Requiring Support Under Disaster Situation in evacuation shelters."

However, in reality, most of the municipalities were so preoccupied with handling the evacuation of the residents that they could not respond to the evacuation of the hospitalized patients at all. An official of Okuma Town,[68] in relation to the fact that they evacuated over 90 percent[69] of the town residents and transferred the municipal government on March 12, followed by the evacuation of the hospitalized patients, commented: "We sent buses to the hospitals as well. But since the Disaster Provision Main Office of Okuma town made a request to the SDF to help implement the evacuation of all the hospitalized patients, we thought that everything would work out after the SDF arrived." However, in reality, the SDF got to the hospital on March 14 and later. Furthermore, an official of Futaba Town[70] expressed his perception as follows: "we think that evacuation of the hospitals should be managed by themselves."

Namie Town, the location of Nishi Hospital, dispatched employees to the hospital and urged evacuation, but it did not arrange appropriate transportation for the evacuation of its seriously ill patients. A municipal staff member of Tomioka Town,[71] the location of Imamura Hospital, said, "We tried to arrange buses, but all of the buses in the Hamadori region of Fukushima Prefecture were already on the road, so we could not find even one. After the town government evacuated at 16:00 on March 12, we heard that those at the hospitals, etc. left behind would receive 'special treatment' rather than assistance from the town government. That 'special treatment' ended up being the assistance of the SDF and the prefectural police in evacuation." This means it was difficult for the town government to arrange evacuation transportation.

To sum up, the municipalities left the evacuation of the hospitals completely to the SDF or to the hospitals themselves.

c. Preparedness for nuclear disasters by the medical institutions in the vicinity of the nuclear plant

None of the staff at six of the seven hospitals knew that the Prefecture Regional Disaster Prevention Plan stipulated that the hospitals have to evacuate their patients on their own in the event of a nuclear disaster.[72] Imamura Hospital was the only hospital that had prepared an evacuation manual to be utilized in the event of a nuclear accident, and it was not a well-prepared one; it failed to anticipate either a need to evacuate all hospitalized patients or a complex disaster. A staff member of the hospital stated that "the manual was completely useless because this kind of accident was unforeseen."

[67] Fukushima Prefecture Disaster Prevention Conference, "Fukushima-ken Chiiki Bosai Keikaku Genshiryoku Saigai Taisaku-hen (Fukushima Prefecture Regional Disaster Prevention Plan: Nuclear Emergency Response Section)," revised in FY 2009, 57 [in Japanese].

[68] Hearing with municipal staff

[69] See Figure 4.2.2-3: Percentage of evacuated residents

[70] Hearing with municipal staff

[71] Hearing with municipal staff

[72] Hearing with hospital staff

In addition, the staff at hospitals that had not prepared manuals made statements such as: "We originally had not foreseen a situation in which the hospitals within a 20km radius from the nuclear plant would have to evacuate all hospitalized patients. We needed assistance from the government"; "Given that we had no lifeline or means of communication, we were completely helpless in evacuating all hospitalized patients, even if we were instructed to do so"; "It was impossible for us to find, by ourselves, transportation for all the hospitalized patients and hospitals to which all of them could be transferred, unless the number of hospitalized patients was around ten"; and so on. A staff member of the Fukushima Prefecture Hospital Association[73] said that "neither the earthquake evacuation drills nor the nuclear accident drills were implemented based upon a prior anticipation of having to evacuate all hospitalized patients. Furthermore, they were based on the assumption that the lifeline would be functioning."

4. *Problems in the evacuation plans of medical institutions in preparation for a large-scale nuclear disaster*

Securing evacuation shelters and transportation at an early stage can substantially alleviate the burden imposed on patients during an evacuation after a nuclear disaster. Following this accident, securing the evacuation shelters and transportation depended upon the individual effort of each hospital, which means it was not institutionally guaranteed. It was not even guaranteed that the hospitals that could secure evacuation shelters and transportation in response to this accident would be able to secure additional evacuation shelters and transportation if another nuclear disaster occurred. We conclude that it is necessary to develop systems to respond to nuclear disasters.

a. Lack of institutional guarantees in securing evacuation shelters and tranportation

The main factors which enabled several hospitals to secure evacuation shelters and transportation were unique circumstances, such as; (1) they had easy access to important information due to their close proximity to the Off-site Center, (2) they requested emergency disaster relief dispatched from the SDF, and (3) they had forged close ties with hospitals outside of the evacuation zone, etc. This means securing evacuation shelters and transportation was not institutionally guaranteed.

(i) Methods of securing evacuation shelters and transportation: the Case of Fukushima Prefectural Ono Hospital

Since Fukushima Prefectural Ono Hospital is located near the Off-site Center and had been designated as the Primary Radiation Emergency Medical Institution, the hospital had interacted with the Off-site Center on a daily basis, such as with nuclear disaster prevention drills. Although the means of communication were cut off due to the earthquake, hospital employees traveled easily between the hospital and the Off-site Center. The hospital was able to quickly obtain information about evacuation orders and to secure transportation, including buses. As a result, the hopital completed its evacuation of all its hospitalized patients on the morning of March 12, 2011, even earlier than the evacuation of the residents of Okuma Town. The evacuation shelter was found during the bus trip; the location was the health, welfare and medical care complex in Kawauchi Village.

(ii) Methods of securing evacuation shelters and transportation: The Case of Futaba Kosei Hospital

Futaba Kosei Hospital was fortunate because a doctor working for the hospital was an old friend of the doctor working for the Fukushima Medical University Hospital (FMU Hospital), who visited the prefectural government office after the earthquake disaster. Since the latter was a member of the Disaster Medical Assistance Team (DMAT), he hurried to the FHDC immediately after the disaster occurred. [74]

He contacted the hospital director of Futaba Kosei Hospital by telephone to inform him that the nuclear power plant was in a dangerous situation. He also asked the SDF:

[73] Hearing with Fukushima Prefectural Hospital Association staff

[74] Hearing with doctors at Fukushima Medical University Hospital

"Could the SDF go to rescue the hospital patients at the direction of the Governor?"[75] in order to direct the SDF to send helicopters. As a result, the evacuation of all the hospitalized patients from this hospital was completed during the morning of March 13, 2011.[76]

(iii) Methods of securing evacuation shelters and transportation: The Case of Minamisoma Municipal Odaka Hospital

Minamisoma Municipal Odaka Hospital arranged an evacuation shelter on March 12, 2011 at the Minamisoma Municipal General Hospital (located inside the 30km radius zone from the nuclear power plant), where the hospital already had a connection. This is why the hospital was able to complete its evacuation of all its hospitalized patients on the following day, March 13, using ambulances and buses arranged by its employees.

(iv) The cases of the four remaining hospitals, where the evacuation was delayed longer than the evacuation of the neighborhood residents

In the cases of Imamura Hospital, Nishi Hospital, Odaka Akasaka Hospital and Futaba Hospital, where the evacuations were delayed longer than the evacuation of the neighbourhood residents, the hospital employees were forced to leave the building to directly ask the town government, the police, and the SDF, etc., for evacuation assistance since most means of communication were cut off due to the earthquake.

In the case of Nishi Hospital, where most of the hospitalized patients were seriously ill, although hospital employees received an offer from a Namie Town government employee and the prefectural police to transfer all its hospitalized patients by bus, they turned down the offer because it would jeopardize the survival of the patients. Instead they waited for the helicopters of the SDF. This is why the evacuation of all the hospitalized patients in the hospital was delayed, and not completed until the night of March 14, 2011. In the case of Imamura Hospital, hospital employees asked the prefectural police and the prefectural government for assistance; they completed their evacuation over the period from the night of March 13, 2011 to dawn of the next day.

In the cases of Odaka Akasaka Hospital and Futaba Hospital, although the hospital employees ran through the town asking for evacuation assistance from the fire department and the prefectural police, etc., those organizations were not able to provide such assistance. In the end, Odaka Akasaka Hospital commenced evacuation on the night of March 14, 2011 and Futaba Hospital commenced its evacuation on the morning of March 15, 2011.

b. Lack of anticipation of a large-scale nuclear disaster in the Prefecture Regional Disaster Prevention Plan

The Prefecture Regional Disaster Prevention Plan stipulates that the evacuation of hospitalized patients shall basically be implemented by the hospitals on their own. According to the Prefecture Regional Disaster Prevention Plan, "managers of schools, hospitals, factories and other facilities which are important for disaster prevention shall create evacuation plans in their respective fire prevention plans, with careful attention to the following matters, and shall expend all possible means to execute evacuation countermeasures." It stipulates evacuation plans for hospitals as follows: [77]

"Hospitals shall anticipate cases in which they have to collectively evacuate the patients to other medical institutions or safe places, and define in advance how to ensure health and hygiene inside the hospital in the case of a disaster, how to secure shelters to which the hospitalized patients will be transferred, where to ward patients who need to be transferred temporarily, how to secure the transportation, how to guide

[75] In the hearing with doctors at FMU Hospital the doctors said, "There was no order from the prefectural governor, but the nuclear plant was in a dangerous situation and there was no other way to help the hospital patients."

[76] It was reported that even after this the doctors continued to direct the evacuation of the hospitalized patients from the hospitals, and made the same appeal for Japan Self-Defence Forces helicopters with respect to Imamura Hospital and Nishi Hospital as well. Hearing with doctors at FMU Hospital

[77] Fukushima Prefecture Disaster Prevention Conference, "Fukushima-ken Chiiki Bosai Keikaku Genshiryoku Saigai Taisaku-hen (Fukushima Prefecture Regional Disaster Prevention Plan: Nuclear Emergency Response Section)," revised in FY 2009, 15 [in Japanese].

patients (subject to the severity of their medical conditions), how to secure transportation vehicles, and how to inform outpatients of safe evacuation places and evacuation shelters in the vicinity of the hospitals, etc."

However, the Prefecture Regional Disaster Prevention Plan was not based upon anticipation of a nuclear accident on such a scale that a large evacuation zone with a 20km radius from the plant would be designated. (See 4.3 regarding the fact that the Prefecture Regional Disaster Prevention Plan had not been set based upon anticipation of the establishment of a large-area evacuation zone.)

In fact, a member of the FHDC's Rescue Squad admitted this flaw in the Prefecture Regional Disaster Prevention Plan when he said that "evacuations of entire hospitals were not expected in the Prefecture Regional Disaster Prevention Plan."

The accident revealed that in a large-scale nuclear disaster, the evacuation of entire hospitals could not be implemented in accordance with the Prefecture Regional Disaster Prevention Plan stipulation that hospitals shall secure, on their own, medical institutions as evacuation shelters and transportation suitable for the evacuation of seriously ill patients.

We can conclude that it is essential to prepare new countermeasures, utilizing lessons learned from the accident, in order to prevent future situations in which hospitalized patients who are unable to evacuate under their own power during a disaster are left behind, resulting in many deaths. It is necessary for prefectures (including Fukushima Prefecture) and municipalities where nuclear plants are located, and for medical institutions in the vicinity of nuclear plants, to consider and develop revisions of their nuclear disaster response manuals, disaster prevention drills, means of communication, coalitions with other municipalities in case of an accident, and so on, in order to better provide evacuation assistance to hospitalized patients in the case of a disaster.

4.3 Flaws in the government's nuclear emergency preparedness

Despite the numerous issues regarding nuclear emergency preparedness that were raised prior to the accident, regulators did not conduct a review of emergency preparedness. The regulator's failure to take timely action on such issues consequently contributed to the accident response failures that were witnessed during the accident.

NSC began a review of the Emergency Preparedness Guide in 2006, in order to incorporate international standards in protective actions. NISA believed, however, that the introduction of international standards would cause concern among residents, and that the residents' worries might impact the pluthermal plan that was being promoted. NSC was unable to respond to NISA's concerns by fully explaining how the review would help protect the residents, so the introduction of international standards was effectively forgone. Although the review of the Emergency Preparedness Guide continued after 2007 at closed study meetings among stakeholders, the accident at the Fukushima Daiichi plant occurred as NSC's review at the Special Committee on Nuclear Disaster was about to proceed in a substantive way.

After the Niigata-ken Chuetsu-oki Earthquake in 2007, calls for establishing nuclear emergency preparedness measures that anticipated a complex disaster increased. In response, NISA attempted to develop measures to cope with complex disasters, while continuing to assume a low probability of their occurrence. However, the government's relevant organizations and some municipalities that hosted nuclear facilities opposed such measures on the grounds that they would create significant burdens on them, among other reasons. Before NISA could achieve a breakthrough, this accident occurred. NISA had also maintained a passive stance toward emergency drills in preparation for a complex disaster.

Meanwhile, the government's annual comprehensive nuclear emergency preparedness drills failed to anticipate a severe accident or complex disaster. As the scope of the drills expanded, they lost substance to the point where they were conducted essentially for the sake of being conducted. It was impossible for the participants in these non-practical drills to deepen their understanding of nuclear emergency preparedness systems, notably the System for Prediction of Environmental Emergency Dose Information (SPEEDI). In the wake of this accident, many participants indicated that they felt the drills were useless.

To aid in protecting residents in the event of a disaster, the government has been developing the Emergency Response Support System (ERSS) and SPEEDI. The Environmental Radiation Monitoring Guidelines assumed that actions to protect residents, including evacuation, would be considered by referencing forecasts of the nuclide types of radioactive material and the hourly amount of release (release source information) using ERSS, and, based on the results, that further forecasts of the dispersion of radioactive material and other information would be made using SPEEDI. This approach was repeatedly practiced at the annual comprehensive nuclear emergency preparedness drills.

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.

The design of the radiation emergency medical system did not anticipate the possibility that radioactive material would be released over a wide area and that many residents would be exposed, as was the case in this accident. Specifically, the accident clearly showed that most of the existing emergency medical facilities were incapable of fulfilling their intended purposes if many residents are exposed to radiation. The medical facilities were too close to the nuclear power plant, they had limited capacity, and the medical staff did not have sufficient medical training to treat radiation exposure.

4.3.1 The review process of the Emergency Preparedness Guide

In the wake of the accident, evacuation zones were not established according to the predicted dispersion of radioactive material assumed in the previous Regulatory Guide: Emergency Preparedness for Nuclear Facilities (Emergency Preparedness Guide), but rather according to concentric circles from the nuclear power plant.

Five years before the accident, nuclear emergency preparedness practitioners began to consider a review of the Emergency Preparedness Guide—including the establishment of evacuation zones in concentric circles . The review, however, was slow to make progress.[78]

1. *Japan's nuclear emergency preparedness framework*

Japan's nuclear emergency preparedness framework is set forth pursuant to laws and ordinances, disaster prevention plans, the NSC's guides and reports (such as the Emergency Preparedness Guide), disaster prevention manuals, and treaties (see Figure 4.3.1-1).

Nuclear emergency preparedness measures – of which disaster prevention plans and

[78] This section is based on comments by Haruki Madarame, Nuclear Safety Commission Chairman, at the 4th NAIIC Commission meeting, by Kenkichi Hirose, former Director-General of Nuclear and Industrial Safety Agency, at the 8th NAIIC Commission meeting, and on hearings with related persons and documents (both related persons and documents from the Nuclear and Industrial Safety Agency [NISA], the Nuclear Safety Commission [NSC], the Japan Nuclear Energy Safety Organization [JNES], the Japan Atomic Energy Agency [JAEA], and the Federation of Electric Power Companies [FEPC]).

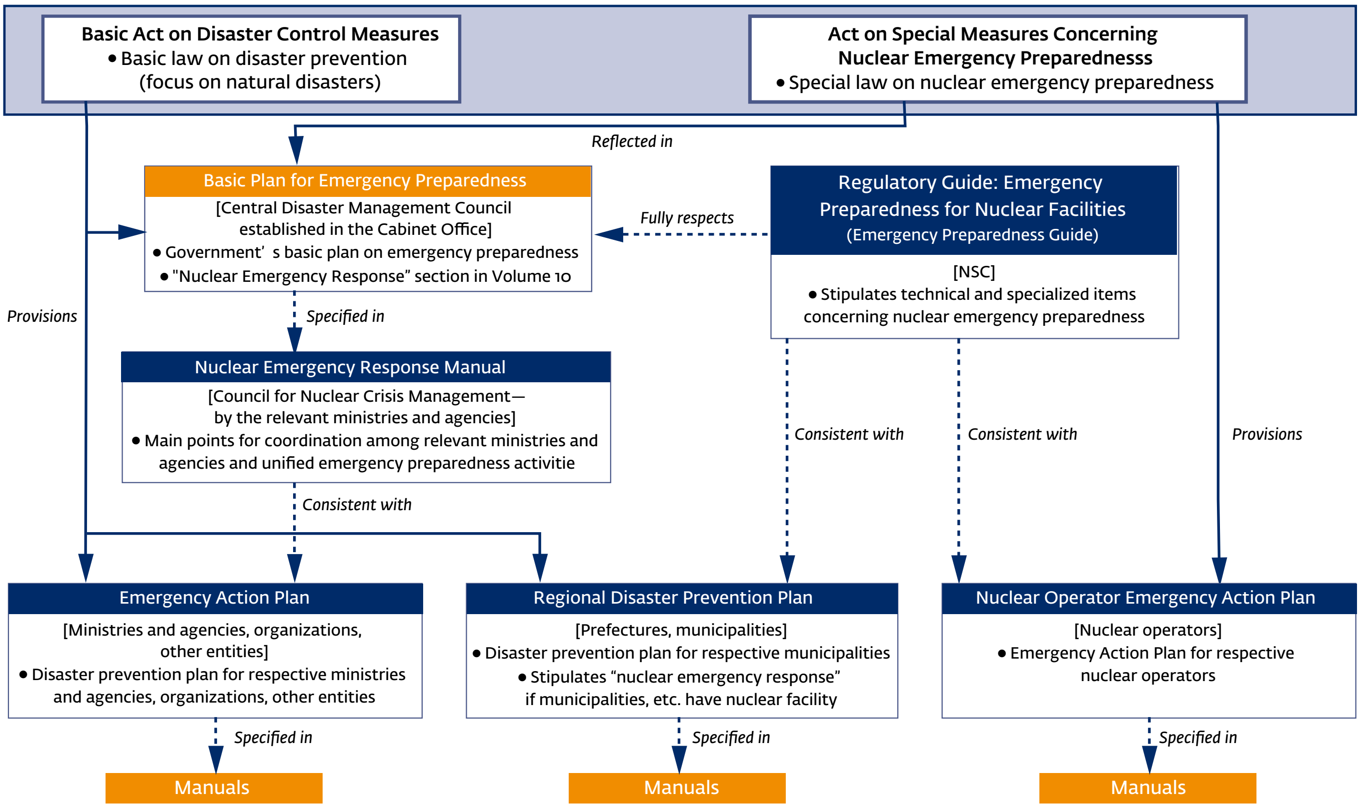


Figure 4.3.1-1: Relationship Between Nuclear Emergency Preparedness Laws and Manuals, etc.

NSC's guides form a core part – have been developed based on, among other considerations, lessons learned from the Three Mile Island nuclear accident in the U.S. Prompted by the criticality accident at the uranium processing plant of JCO Co., Ltd. on September 30, 1999 (the JCO Accident), the Act on Special Measures Concerning Nuclear Emergency Preparedness (the Nuclear Emergency Preparedness Act) was enacted in December 1999. Various disaster prevention plans and the Emergency Preparedness Guide were developed accordingly, and they shape the current framework.

2. *The role and revision process of the Emergency Preparedness Guide*

NSC compiled the Emergency Preparedness Guide as a set of guidelines to assist the stakeholders, including the government, municipalities, and nuclear operators, in establishing nuclear emergency preparedness plans and implementing protective measures during emergencies. The nuclear emergency response section of the Government's Basic Plan for Emergency Preparedness, Volume 10 (now Volume 11), specifies that the Emergency Preparedness Guide should be fully followed regarding technical and specialized items pertaining to emergency preparedness. The Emergency Preparedness Guide and the Nuclear Emergency Preparedness Act are the central pillars of the measures to protect residents during nuclear emergencies.

The current Emergency Preparedness Guide was established in 1980 in light of the Three Mile Island nuclear accident. Revisions have since been made in the wake of the JCO Accident and international trends. Nonetheless, a drastic review of the Emergency Preparedness Guide has not been carried out, because of the belief that a Chernobyl-type nuclear accident could not occur in Japan.

In 2006, NSC began to consider revising the Emergency Preparedness Guide to incorporate the concept of implementing protective actions that had become the international standard. Due to opposition from NISA, however, sufficient revisions were not carried out. In 2010 and 2011, NSC again attempted to start a review of the Emergency Preparedness Guide at the Special Committee on Nuclear Disaster. Then the Fukushima Daiichi plant accident occurred.

Based on the way the review of the Emergency Preparedness Guide was handled from 2006 and beyond, we see that NSC and NISA both neglected to make the safety of residents a priority.

3. *Outline of the considerations undertaken in 2006*

a. Events leading to consideration of the adoption of PAZ, etc.

Figure 4.3.1-2: Outline of considerations undertaken for reviewing the emergency preparedness guide (2006-2007) [79]

	Date	Event
2006	March 14	Emergency Preparedness Guide Working Group is established at NSC (at the 13th meeting of NSC Special Committee on Nuclear Disaster)
	March 29	2006 1st Meeting of Emergency Prepardeness Guide Working Group
	April 18	NSC informs NISA of a plan to incorporate IAEA concepts into Emergency Preparedness Guide
	April 24	NISA submits to NSC "Considerations for Emergency Preparedness Guide (Opinions)"
	April 26	NISA submits to NSC "Request (Memo)"; requests halt of study for review of Emergency Preparedness Guide
	April 27	2006 2nd Meeting of Emergency Preparedness Guide Working Group
		NISA requests NSC by telephone to halt study for review of Emergency Preparedeness Guide
	May 24	Lunch meeting between NSC and NISA (NISA requests NSC to carefully conduct study for review of Emergency Preparedness Guide)
	June 9	NSC presents to NISA draft revision of Emergency Preparedness Guide (material planned for 3rd Meeting of Emergency Preparedness Guide Working Group); NISA submits "Opinions Regarding Paper on Considerations for Emergency Preparedness Guide" and requests modifications
	June 14	NSC submits to NISA "Opinions Regarding Paper on Considerations for Emergency Preparedness Guide (Response)" and replies that NISA's request cannot be accepted
	June 15	NISA submits to NSC "Opinions on Considerations for Emergency Preparedness Guide" and once again requests NSC to review the draft revision of Emergency Preparedness Guide
	June 19	NSC presents new draft revision to NISA; NISA requests reconsideration of draft revision
	July 4	NSC and NISA agree on draft revision of Emergency Preparedness Guide
	August 2	2006 3rd Meeting of Emergency Prepardeness Guide Working Group
	October 5	2006 4th Meeting of Emergency Prepardeness Guide Working Group
	November 28	2006 5th Meeting of Emergency Prepardeness Guide Working Group (draft revision of Emergency Preparedness Guide compiled)
	December 14	14th Meeting of Special Committee on Nuclear Diaster
2007	April 24	15th Meeting of Special Committee on Nuclear Diaster (Fukui Prefecture makes request)
	May 24	34th Extraordinary Meeting of NSC (draft revision of Emergency Preparedness Guide decided)

(shaded) Exchanges between NSC and NISA

In November 2005, the International Atomic Energy Agency's (IAEA) Commission on Safety Standards (CSS) approved the Safety Guide (No. DS-105 [now No. GS-G-2.1]) titled Arrangements for Preparedness for a Nuclear or Radiological Emergency. Following this, on March 14, 2006, NSC set up the Emergency Prepardeness Guide Working Group in the Special Committee on Nuclear Disaster. NSC began to study how the international standards adopted in DS-105 could be integrated into the Emergency Preparedness Guide. The following section explains the problems of the existing Emergency Preparedness Guide, as well as the background on how NSC began to consider the adoption of international standards.

Figure 4.3.1-3 summarizes the international standards set forth in the Safety Guide of IAEA.

The existing Emergency Preparedness Guide does not embody concepts that corre-

[79] Compiled from NSC Secretariat, "Heisei 18nen no PAZ-to ni kansuru Bosai Shishin Minaoshi ni okeru Genshiryoku Anzen, Hoanin kara no Moshiire, Iken-to ni kansuru Keii ni tsuite (Background of NISA's Requests, Opinions, etc. Regarding Review of the Emergency Preparedness Guide Concerning PAZ, etc. in 2006)," March 15, 2012 [in Japanese]. Accessed June 22, 2012, www.nsc.go.jp/info/20120315.html, and NISA documents.

Figure 4.3.1-3: Summary of international standards set forth in the safety guide of IAEA

PAZ Precautionary Action Zone	*Area within which precautionary protective actions (e.g., evacuation), which are planned prior to the release of radioactive material into the environment, are implemented shortly after the release if the emergency classification* is deemed to be a "General Emergency," based on a recognition that the release of radioactive material is difficult to predict in an accident's immediate aftermath. According to IAEA's Safety Guide No. GS-G-2.1, this is the area located 3-5km from the nuclear power plant.*
UPZ Urgent Protective Planning Action Zone	*Area where preparations are made to implement urgent protective actions, including evacuation, shelter-in-place, and administration of stable iodine, in accordance with EAL and OIL, in order to reduce the impact of exposure, based on a recognition that no time can be spared to make a fully-considered judgment during an emergency situation. According to IAEA's Safety Guide No. GS-G-2.1, this is the area 5-30km from the nuclear power plant.*
EAL Emergency Action level	*A criterion set forth by the operator by taking various conditions into account, including the situation of the plant (e.g., nuclear facility, spent fuel pool), discharge of radioactive material, and the external situation, used to determine the emergency classification* for the implementation of protective actions.*
OIL Operational Intervention Level	*A criterion based on environmental radiation monitoring measurements for implementing a range of protective actions (e.g., sheltering, evacuation, administration of stable iodine), which is set according to different stages on the basis of measurable parameters, including air dose rate and surface contamination concentrations. Protective actions based on EAL are implemented in an accident's immediate aftermath. When an OIL value is measured through environmental radiation monitoring, protective actions based on OIL are implemented.*

**Emergency classification: IAEA classifies emergency situations into four categories of "Alert," "Facility Emergency," "Site Area Emergency," and "General Emergency."*

spond to the Precautionary Action Zone (PAZ).[80] The Emergency Preparedness Guide establishes the Emergency Planning Zone (EPZ) for nearly the same purpose as that of the Urgent Protective Action Planning Zone (UPZ)[81] (an area where emergency preparedness measures should be implemented quickly and substantively; approximately 8 to 10km from the nuclear power plant).

Moreover, in Japan, specified protective measures that consider the conditions at nuclear facilities have not been prepared in advance. Protective measures have been prepared only insofar as they can be decided based on data from emergency projection systems, such as ERSS and SPEEDI. Accordingly, if projecting the release of radioactive material using ERSS or SPEEDI fails, or if projections are not made promptly, residents face the risk of not being able to find shelter, evacuate smoothly, or avoid exposure to radiation.

Since around 2006, nuclear energy preparedness practitioners began questioning the method of determining protective actions by relying on emergency projection systems, such as ERSS and SPEEDI. Specifically, questions were raised as to the reliability of accident simulation analyses using ERSS, or SPEEDI's radioactivity impact projections that utilized ERSS data.[82] In addition, during the review of the Emergency Preparedness Guide in 2006, it was pointed out that while core damage was sometimes predictable, predictions of containment vessel failure, etc. were extremely difficult to make, and furthermore, it was virtually impossible to make accurate predictions about

[80] The existing Emergency Preparedness Guide states that, "While (the Emergency Preparedness Guide) does not include any provisions on the establishment of zones within the radius corresponding to PAZ, it already introduces EPZ as an 'area within which the Emergency Preparedness Guide shall be implemented with priority and substantively.'" However, it is pointed out that PAZ, as stated in the Emergency Preparedness Guide, may refer to UPZ (NSC documents).

[81] NSC, "Genshiryoku Shisetsu-to Bosai Senmon Bukai Bosai Kento Wakingu Gurupu Dai 3kai Haifu Shiryo 'IAEA Bunsho ni oite Shimesareta Kinkyu Bogo Sochi Keikaku Hani (UPZ) ni tsuite' (Material Distributed at the 3rd Meeting of the Working Group for Emergency Preparedness Guide, Special Committee on Nuclear Disaster, [Urgent Protective Action Planning Zone (UPZ) Indicated in IAEA Document])," August 2, 2006 [in Japanese]. Accessed June 22, 2012, www.nsc.go.jp/senmon/shidai/bousin/bousin003/siryo3.pdf.

[82] In response to these questions, for example, the government's comprehensive nuclear emergency preparedness drills in FY2006 considered proposals on protective measures, including evacuation of residents, from the stage of notification pursuant to Article 10 of the Nuclear Emergency Preparedness Act. However, these were not drastic reviews.

the amount of radiation emissions and the dose at the initial post-accident phase when protective actions needed to be determined.[83] The question of whether evacuation orders could really be made by relying on SPEEDI's calculation results, given these uncertainties, was noted at NSC's meeting (convened approximately one month prior to the accident) on nuclear emergency preparedness drills.

This method of determining protective actions by relying on emergency projection systems was found in no other country. Hence, NSC began to review the Emergency Preparedness Guide, in order to introduce protective actions which would not rely on projection methods.

b. NISA's opposition

As NSC began to review the Emergency Preparedness Guide, from April to June 2006, NISA repeatedly requested the NSC to halt the study by submitting opinion letters and other means.[84] NISA opposition to the review of the Emergency Preparedness Guide did not take into account the perspective of ensuring the safety of residents, thereby ignoring NISA's primary mandate as a regulator.

NISA's main reasons for requesting a halt to the review may be summarized by the following: (1) NISA was displeased that, despite having reviewed the enforcement status of the Nuclear Emergency Preparedness Act by March 2006 and concluding that the Nuclear Emergency Preparedness Act itself did not need to be revised,[85] NSC began to review the Emergency Preparedness Guide without fully consulting NISA (from NISA's perspective); [86] (2) NISA believed that residents might misunderstand PAZ as areas from which residents must immediately and unconditionally evacuate, and therefore, it was necessary to avoid any increase in residents' concern and confusion that might result from changes made to previous explanations; and (3) NISA was concerned about the impact of the review on the explanations provided to residents regarding the pluthermal introduction plan. These reasons contradict the purpose of NISA's establishment, which is to ensure nuclear safety, and run counter to NISA's intended role as a regulator.

First, the displeasure mentioned in reason (1) was not necessarily shared by everyone at NISA. In 2006, some NISA deputy directors-general found it unsatisfactory that Japan's existing emergency preparedness system was removed from international standards, and expressed the opinion that the Emergency Preparedness Guide should be reviewed. However, Kenkichi Hirose, NISA Director-General at that time, believed that the existing system, based on the Nuclear Emergency Preparedness Act, should be kept for at least a decade, and concluded that the Emergency Preparedness Guide need not be reviewed.[87] Although NISA's Nuclear Emergency Preparedness Division recognized the possibility of not being able to utilize ERSS in times of urgent decision-making,[88] it agreed with the director-general's stance in view of the impact that the review would have on the judgment that the Nuclear Emergency Preparedness Act need not be revised.

As to reason (2), NISA expressed its wish not to increase residents' concerns or cause confusion. Nevertheless, there are no signs indicating that NISA specifically considered whether the introduction of PAZ and other standards would increase resi-

[83] NSC, "Genshiryoku Shisetsu-to Bosai Senmon Bukai Bosai Shishin Kento Wakingu Gurupu Dai 1kai Sokkiroku (Record of the 1st Meeting of the Working Group for Emergency Preparedness Guide, Special Committee on Nuclear Disaster)," 2006 [in Japanese]. Accessed June 22, 2012, www.nsc.go.jp/senmon/soki/bousin/bousin_so01.htm.

[84] NSC Secretariat, "Heisei 18nen no PAZ-to ni kansuru Bosai Shishin Minaoshi ni okeru Genshiryoku Anzen, Hoanin kara no Moshiire, Iken-to ni kansuru Keii ni tsuite (Background of NISA's Requests, Opinions, etc. Regarding Review of the Emergency Preparedness Guide Concerning PAZ, etc. in 2006)," March 15, 2012 [in Japanese]. Accessed June 22, 2012, www.nsc.go.jp/info/20120315.html.

[85] Nuclear Emergency Preparedness Review Council, Council on Nuclear Safety Regulation and Other Matters, Ministry of Education, Culture, Sports, Science and Technology, "Genshiryoku Saigai Taisaku Tokubetsu Sochiho no Shiko Jokyo ni tsuite (Status of the Entry into Force of the Act on Special Measures Concerning Nuclear Emergency Preparedness)," March 2006 [in Japanese]. Accessed June 22, 2012, www.mext.go.jp/b_menu/shingi/chousa/gijyutu/004/014/shiryo/__icsFiles/afieldfile/2009/05/13/20070806_02e.pdf.

[86] NISA, "Bosai Shishin no Kento ni taisuru Iken (Opinions on the Study of the Emergency Preparedness Guide)," June 15, 2006 [in Japanese]. Accessed June 22, 2012, www.nsc.go.jp/info/20120315/siryo12.pdf.

[87] NISA documents

[88] NISA documents

dents' concerns or cause confusion.

The reference to the pluthermal introduction plan described in reason (3) demonstrates NISA's inclination to promote nuclear power, despite being, in theory, an independent body not affiliated with the promotion of nuclear power.

Underlying NISA's views was the conviction that, with regard to nuclear emergency preparedness, it was not necessary to anticipate an accident that would release enough radioactive material as to actually require protective actions, since (they believed) rigorous nuclear safety regulations, including safety inspections and operation management,[89] were in place in Japan. Japan's nuclear site licenses are issued on the basis of a facility's basic design; the facility's overall safety, including whether a nuclear emergency preparedness system is established, is not confirmed at the time of license issuance. Regulators should have striven to protect the residents, given that the government has not confirmed the safety of all facilities. However, based on the communications made prior to the accident, there is little to no evidence of such a stance.[90]

c. NSC's effective forgoing of the introduction of PAZ, etc.

In the draft revision of the Emergency Preparedness Guide, NSC had prepared a section of text that stated, "In response to a disaster at a nuclear power plant, it is also effective to implement urgent protective action before or shortly after a release of radioactive material, on the basis of conditions at the facility in order to avoid, in particular, definite effects."[91] Nevertheless, in response to NISA's opposition, this content was changed to, "It is sometimes effective to implement protective measures, including sheltering and evacuation, before or shortly after a release of radioactive material, etc., in view of the future outlook of the regional situation and circumstances, etc."[92] This text means that it is sometimes effective to carry out protective action based on the region's individual situation, i.e., individual responses based on individual judgments are necessary. In this vein, the contents of the draft revision of the Emergency Preparedness Guide did not fully reflect PAZ's concept of taking protective actions set forth in advance if certain conditions are met.[93] There is little to no evidence that in the process of these revisions, NSC tried to convince NISA that the introduction of international standards, including PAZ, was necessary for the protection of the residents.

In the end, the Emergency Preparedness Guide revised in May 2007 stated that, "It is also effective to implement protective measures, including sheltering and evacuation, before a release of radioactive material, etc. occurs or shortly after a release of radioactive material, etc. begins, according to the future outlook of the regional situation and circumstances, etc." The introduction of international standards, including PAZ, was, in effect, forgone.

PAZ and UPZ will not function unless the emergency classification, which serves as a prerequisite to initiate the response, and their criteria (EAL and OIL) are specified in concrete terms, precisely because they are zones for initiating protective measures

[89] NISA documents

[90] The view is not in line with the logic of assuming the failure of preceding protective actions, which forms the core element of IAEA's five levels of Defence in Depth (see Reference Materials [in Japanese] 6.1.2).

[91] NSC documents

[92] NSC documents

[93] In addition to the examples stated in the text, the Commission has found other shortfalls with NSC's study on the review of the Emergency Preparedness Guide.
For example, at the meetings of Emergency Preparedness Guide Working Group, views were expressed that the guide should anticipate accidents causing not only the release of noble gas and iodine from nuclear reactor facilities, but also the release and radiation of other radioactive material, such as cesium. However, no specific considerations were given. In addition, in 2007, in response to the draft revision of the Emergency Preparedness guide, many critical opinions were received regarding the fact that the draft revision makes no mention of nuclear disasters caused by earthquake disasters. However, a review was not conducted on this basis.
Furthermore, in the Regulatory Guide for Reviewing Seismic Design of Nuclear Power Reactor Facilities, which was revised on September 19, 2006, NSC acknowledged the presence of "residual risk" (risk of a facility sustaining major damage and releasing a large amount of radioactive material due to a larger than anticipated ground motion). However, the Emergency Preparedness Guide did not set forth protective measures, which take into account earthquake disasters in light of the "residual risk."
NSC, "Genshiryoku Shisetsu-to Bosai Senmon Bukai Dai 15kai Sokkiroku (Record of 15th Meeting of the Special Committee on Nuclear Disaster)," April 24, 2007 [in Japanese]. Accessed June 22, 2012, www.nsc.go.jp/senmon/soki/sisetubo/sisetubo_so15.pdf.

automatically for a certain class of emergency. However, NSC did not give sufficient consideration to EAL and OIL when studying the introduction of PAZ. NSC received criticism from municipalities that host nuclear facilities in this regard. [94]

4. *Outline of the considerations undertaken in 2007 and beyond*

a. Status of considerations for the adoption of PAZ, etc. in 2007 and beyond

Following the revision of the Emergency Preparedness Guide in 2007, NSC commissioned the Japan Atomic Energy Agency (JAEA) to conduct a study of PAZ in FY2009. [95] From that same year, in response to NISA's proposal, the NSC held continuous study meetings on PAZ, etc. with the Japan Nuclear Energy Safety Organization (JNES), JAEA, NISA, and the Office of Emergency Planning & Environmental Radioactivity of the Nuclear Safety Division of MEXT. At that time, in contrast to its position around 2006, NISA did not oppose the introduction of PAZ, etc. and it participated in the study meetings, due to changes in top officials at NISA, among other factors.

Meanwhile, in 2010, the IAEA approved a Safety Guide on EAL, etc. (No. DS-44 [now No. GS-G-2.1]), the Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency.

In light of such international trends and given that it had obtained the understanding of nuclear emergency preparedness stakeholders, NSC decided to begin a review of the Emergency Preparedness Guide on December 2, 2010.[96] However, the revision of the Emergency Preparedness Guide had not been completed when the accident occurred.

b. Hasty discussions and underlying laxity in assumptions about accidents

Figure 4.3.1-4: Outline of considerations undertaken for reviewing the Emergency Preparedness Guide (2010-2011) [97]

	Date	Event
2010	October 12	NSC requests FEPC, etc. to provide data
2010	December 2	74th Extraordinary Meeting of NSC (The Basic Policies for the Near-Term Initiatives of the Nuclear Safety is revised; NSC decides to study incorporation of iFEPC reports situation to NSC
2010	December 3	Meeting between NSC and FEPC
2010	December 22	FEPC reports impact on municipalities to NSC
2011	January 13	FEPC makes additional report on impact on municipalities to NSC
2011	February 3	NSC explains to FEPC, etc. intent to start deliberations for revising Emergency
2011	February 25	Preparedness Guide based on international trends, etc.
2011	March 9	NSC once again requests FEPC to provide weather data

Exchanges between NSC and FEPC

In order to obtain the understanding of the municipalities that host nuclear facilities, NSC made active efforts to revise the Emergency Preparedness Guide; as an example, it participated in briefing sessions for host municipalities, which NSC had until then left up to NISA.

However, NSC's work to review the Emergency Preparedness Guide from 2010 to 2011 was not without its share of overly hasty decision-making. While stating that it

[94] NSC, "Genshiryoku Shisetsu-to Bosai Senmon Bukai Dai 15kai Haifu Shiryo 'Genshiryoku Shisetsu-to no Bosai Taisaku ni tsuite (Bosai Shishin) Kaiteian ni taisuru Iken ni tsuite (Fukushima-ken)' (Material Distributed at 15th Meeting of the Special Committee on Nuclear Disaster, 'Opinions on the Draft Revision of the Regulatory Guide: Emergency Preparedness for Nuclear Facilities (Emergency Preparedness Guide) (Fukui Prefecture)'," April 24, 2007 [in Japanese]. Accessed June 22, 2012, www.nsc.go.jp/senmon/shidai/sisetubo/sisetubo015/siryo2-1.pdf.

[95] JAEA, "Hatsudenyo Genshiro Shisetsu no Saigaiji ni okeru Yoboteki Sochi Hani 'PAZ' no Chosa (Study on Precautionary Action Zones [PAZ] During a Disaster at a Nuclear Reactor Facility for Electric Generation)," March 2010 [in Japanese]. Accessed June 22, 2012, www.nsc.go.jp/senmon/shidai/bousin/bousin2011_04/ssiryo3.pdf.

[96] NSC decision, "Genshiryoku Anzen Iinkai no Tomen no Shisaku no Kihon Hoshin ni tsuite (The Basic Policies for the Near-Term Initiatives of the Nuclear Safety)," December 2, 2010 [in Japanese].

[97] Compiled from NSC Secretariat, "Heisei 22nen kara 23nen ni kakete PAZ-to ni kansuru Bosai Shishin Minaoshi ni Muketa Kento ni okeru Denki Jigyo Rengokai e no Deta Teikyo Irai ni kansuru Keii ni tsuite (Background on Requests Made to FEPC to Provide Data for Studying the Review of the Emergency Preparedness Guide Regarding PAZ, etc. from 2010 to 2011)," March 27, 2012, supplemented on March 28, 2012 [in Japanese]. Accessed June 22, 2012, www.nsc.go.jp/info/20120327.html, and FEPC documents.

would introduce international standards, NSC maintained the EPZ framework of the existing Emergency Preparedness Guide and noted that it would adopt a policy making the EPZ an area with a 10km radius.[98] Thus, among its activities, NSC requested FEPC to provide data on wind direction and other variables for each nuclear facility, in order to confirm the appropriateness of setting the EPZ's suggested radius to 8-10km. [99] The intended conclusion was that changes in the existing framework were unnecessary. [100]

At the same time, while NSC was enthusiastic about the introduction of PAZ and EAL, it was less interested in considering UPZ and OIL. [101]

The NSC stance was questioned by some of the people who participated in the study meetings convened by JNES, JAEA, NISA, MEXT, and NSC.

As its reason for adopting the existing EPZ framework and deciding that a 10km radius zone was sufficient, all the while promoting the introduction of international standards, NSC states that, at the time, it did not anticipate severe accidents with containment vessel failures or accidents caused by a long-term loss of power. Such a view, similar to that of NISA when it opposed the review of the Emergency Preparedness Gude in 2006, fell short of the emergency anticipations which should have been made.

When it considered the introduction of new international standards, NSC insisted on maintaining the existing nuclear safety regulatory system and failed to make drastic changes. In failing to give top priority to the safety of residents, the relevant organizations did not make a sincere effort to review the Emergency Preparedness Guide.

c. Lack of consciousness about emergency preparedness among electric power operators, as seen from the efforts of FEPC

From 2010 to 2011, FEPC expressed its concerns about the review of the Emergency Preparedness Guide to NSC. These included statements such as: "The review will have a significant impact on lawsuits and the like (concerning nuclear plants)"; "The scope of the nuclear operator emergency action plan will expand beyond control"; and, "The review will increase the burden on NISA in dealing with municipalities."[102] FEPC also stated that a review of the recommended size of the EPZ would cause municipalities to request grants, the introduction of PAZ and other international standards would cause municipalities to request road improvements and grants, and that the review would impact the regional economy and might cause residents to harbor doubts about the government's emergency preparedness measures.[103] The FEPC's statements demonstrate that operators did not proactively involve themselves in the emergency preparedness system.

FEPC worried that NSC would reach a conclusion without conducting sufficient discussions about the Emergency Preparedness Guide. FEPC also intended to minimize any impact of revisions to the guide on electric power operators. This is also shown by the fact that FEPC confirmed internally that its policy regarding the review of the guide should be as follows: "Since a sufficient exchange of views among stakeholders

[98] NSC Secretariat, "Uchiawase Memo (Meeting Memo)," October 14, 2010 [in Japanese]. Accessed June 22, 2012, www.nsc.go.jp/info/20120327/siryo2.pdf.

[99] NSC Secretariat, "Heisei 22nen kara 23nen ni kakete PAZ-to ni kansuru Bosai Shishin Minaoshi ni Muketa Kento ni okeru Denki Jigyo Rengokai e no Deta Teikyo Irai ni kansuru Keii ni tsuite (Background on Requests Made to FEPC to Provide Data for Studying the Review of the Emergency Preparedness Guide Regarding PAZ, etc. from 2010 to 2011)," March 27, 2012, supplemented on March 28, 2012 [in Japanese]. Accessed June 22, 2012, www.nsc.go.jp/info/20120327.html.

[100] FEPC documents

[101] For example, UPZ may be determined bearing in mind the possible emergence of areas with a high level of contamination from cesium and other radioactive material locally. However, such considerations cannot be made for EPZ in the Emergency Preparedness Guide. In response to the differences between EPZ and UPZ, participants from NSC noted that it is unlikely in Japan for radioactive material to fall with the rain, creating areas with a high level of contamination, and therefore, the concept of UPZ need not be introduced (NSC and FEPC documents).

[102] FEPC documents

[103] FEPC, "Bosai Shishin no Kaitei Naiyo ni kansuru Ninshiki no Kyoyuka ni tsuite (Recognition Sharing on the Contents of the Revisions of the Emergency Preparedness Guide)," January 13, 2011 [in Japanese]. Accessed June 22, 2012, www.nsc.go.jp/info/20120327/siryo6.pdf;
FEPC, " '1gatsu 13nichi Shiryo no Tsuiho' Kokusai Kijun (PAZ,UPZ,EAL,OIL) Donyu ni tomonau Jichitai Eikyo no Suitei ni tsuite ([Supplement to January 13 material] Assumptions Regarding the Impact on Municipalities Which Accompanies the Introduction of International Standards [International Standards <PAZ, UPZ, EAL, OIL>])," February 3, 2011 [in Japanese]. Accessed June 22, 2012, www.nsc.go.jp/info/20120327/siryo8.pdf.

has not been conducted, it is not desirable for debates to now commence at public forums"; and, "FEPC will make continuous requests to the NSC Secretariat to hold meetings in advance among the stakeholders, including the operators." [104]

5. *The impact on this accident*

In the accident's aftermath, evacuation orders were issued for zones formed by concentric circles from the nuclear power plant. While this was because the situation of the release of radioactive material was unknown, the evacuation orders resembled the concept of PAZ that arose in the discussions on the review of the Emergency Preparedness Guide. At the time of the accident, the nuclear experts who assembled at the Kantei on the fifth floor of the Prime Minister's Office included several who were aware that discussions on the review of the Emergency Preparedness Guide were under way at NSC. In the process of deciding the evacuation orders at the Kantei, NSC Chairman Madarame noted that the review of the Emergency Preparedness Guide was in progress.

On the other hand, prior to the accident, nuclear emergency preparedness practitioners, including the operators, never informed residents, who had participated in the preparedness drills using the ERSS and SPEEDI emergency projection systems, about the review of the Emergency Preparedness Guide. Had residents known about the review of the Emergency Preparedness Guide, including the concept of PAZ, etc., it is possible that on the day of the accident, residents could have evacuated without confusion, even if the evacuation order differed from the preparedness drills.

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. [105]

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

[104] FEPC documents

[105] This section is based on comments by Yuhei Sato, Governor of Fukushima Prefecture, at the 17th NAIIC Commission meeting, and hearings with related persons and documents (both related persons and documents from NISA, Fukushima Prefecture, and Niigata Prefecture).

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). [106]

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. [107]

In response to this request, NISA outsourced research on complex disasters to a private company[108] 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 large-scale 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. [109]

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

[106] Documents from the Disaster Prevention Bureau, Niigata Prefecture

[107] Documents from the Disaster Prevention Bureau, Niigata Prefecture

[108] Tokio Marine & Nichido Risk Consulting Co., Ltd., "Heisei 20nendo Genshiryoku Shisetsu ni kansuru Shizen Saigai-to no Dojiki Hassei e no Taio ni kansuru Chosa Jigyo Hokokusho (FY2008 Report on the research concerning the disaster preparedness of nuclear facilities experiencing natural and other disasters)," February 13, 2009 [in Japanese]. Accessed June 22, 2012, www.meti.go.jp/meti_lib/report/2009fy01/E001833.pdf.

[109] The view is not in line with that of a single failure at one level of defence, and even combinations of failures at more than one level of defence, would not propagate to jeopardize defence in depth at subsequent levels, which forms the core element of IAEA's five levels of Defence in Depth (see Reference Material [in Japanese] 6.1.2).

comments.[110] Some national government agencies and local governments harshly objected to the content,[111] 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 one-sided. 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.”[112] 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. [113]

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.[114] Also, it wasn’t until March 8, 2011 that NISA consulted with the Cabinet Office concerning (i) the future implementation plan.[115] 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

[110] NISA documents

[111] NISA, “‘Genshiryoku Saigai-to to Dojiki mataha Aizengo shite, Daikibo Shizen Saigai ga Hasseisuru Jitai ni Taio shita Genshiryoku Bosai Manyuaru-to no Sakusei-jo no Ryui Jiko (Soan)’ no Kongo no Toriatsukai Hoshin ni tsuite (Future policy on how to use [Consideration of a nuclear disaster prevention manual in preparation for an event whereby a large-scale natural disaster occurs simultaneously or in line with nuclear and other disasters <draft>]),” October 14, 2010 [in Japanese]. Accessed June 22, 2012, www.meti.go.jp/committee/summary/0004125/019_02_01_00.pdf.

[112] NISA documents

[113]METI, “Sogo Shigen Enerugi Chosakai Genshiryoku Anzen Hoan Bukai Genshiryoku Bosai Sho-Iinkai Dai 19kai Gijiroku (Minutes of the 19th meeting, the Nuclear Disaster Prevention Subcommittee of the Nuclear and Industrial Safety Subcommittee of the Advisory Committee for Natural Resources and Energy),” October 14, 2010 [in Japanese]. Accessed June 22, 2012, www.meti.go.jp/committee/summary/0004125/gijiroku19.pdf.

[114] NISA documents

[115] NISA documents

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. [116]

The Nuclear Emergency Response section in the Fukushima Prefecture Disaster Prevention Plan did not specify measures against complex disasters.[117] 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 (see 4.3.3) 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.[118]

On May 19, 2010, Niigata Prefecture consulted with NISA about planning nuclear emergency preparedness drills that included complex disasters.[119] Niigata Prefecture suggested the following scenario: "The Chuetsu region is hit by a strong earthquake.

[116] Niigata Prefecture, which submitted its request to the central government, revised its Regional Disaster Prevention Plan ("Nuclear Emergency Response Section") in September 2009, specifying its measures against complex disasters. It was only Niigata Prefecture and Shizuoka Prefecture that referred to measures against complex disasters as of September 2009.
The Disaster Prevention Bureau, Niigata Prefecture, "Niigata-ken Hodo Shiryo (Niigata Prefecture press material)," September 15, 2009 [in Japanese]. Accessed June 22, 2012, www.pref.niigata.lg.jp/genshiryoku/1253048530880.html.

[117] Fukushima Prefecture Disaster Prevention Conference, "Fukushima-ken Chiiki Bosai Keikaku Genshiryoku Saigai Taisaku-hen (Fukushima Prefecture Regional Disaster Prevention Plan, Nuclear Emergency Response Section)," revised in FY2009 [in Japanese]. Accessed June 22, 2012, www.pref.fukushima.jp/nuclear/old/pdf_files/H21gensaitaisaku.pdf.

[118] NISA, "Heisei 22nendo Niigata-ken Genshiryoku Bosai Kunren no Sotei wo Meguru Keii ni taisuru Kenkai ni tsuite (Discussion on the history of setting an assumption for the 2010 Niigata Prefecture emergency preparedness drill)," December 9, 2010 [in Japanese]. Accessed June 22, 2012, www.nisa.meti.go.jp/oshirase/2010/221209-1.html.
During the discussions, some members preferred the occurrence of troubles not triggered by an earthquake as proposed by NISA. Other members said a scenario involving some troubles triggered by an earthquake would be more acceptable for local residents. (Based on a written response from the Disaster Prevention Bureau of Niigata Prefecture)

[119] NISA, "Heisei 22nendo Niigata-ken Genshiryoku Bosai Kunren no Sotei wo Meguru Keii ni taisuru Kenkai ni tsuite (Discussion on the history of setting an assumption for the 2010 Niigata Prefecture emergency preparedness drill)," December 9, 2010 [in Japanese]. Accessed June 22, 2012, www.nisa.meti.go.jp/oshirase/2010/221209-1.html.
The above website describes how Niigata Prefecture proposed an emergency preparedness drill scenario based on an earthquake measuring lower 5 on the Japanese seismic scale on May 19, 2011. However, Niigata Prefecture was not aware that the prefecture proposed a scenario based on an earthquake measuring lower 5. (A material created by the Disaster Prevention Bureau, Niigata Prefecture and a written response from the Disaster Prevention Bureau, Niigata Prefecture)

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."[120] 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. [121]

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.[122] 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,[123] 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

[120] Documents from the Disaster Prevention Bureau, Niigata Prefecture

[121] Documents from NISA and documents from the Disaster Prevention Bureau, Niigata Prefecture

[122] A written response from the Disaster Prevention Bureau, Niigata Prefecture

[123] NISA, "Heisei 22nendo Niigata-ken Genshiryoku Bosai Kunren no Sotei wo Meguru Keii ni taisuru Kenkai ni tsuite (Discussion on the history of setting an assumption for the 2010 Niigata Prefecture emergency preparedness drill)," December 9, 2010 [in Japanese]. Accessed June 22, 2012, www.nisa.meti.go.jp/oshirase/2010/221209-1.html.

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 large-scale earthquake and a nuclear disaster. [124]

Specifically, the "Earthquake-resistant measures implemented at important nuclear power plant facilities required to offer emergency disaster response,"[125] ("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 earthquake-resistant 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. [126]

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.

[124] MIC, "Genshiryoku no Bosai Gyomu ni kansuru Gyosei Hyoka, Kanshi Kekka ni motozuku Kankoku 'Dai Ichiji' - Daikibo Jishin ni yoru Genshiryoku Hatsudensho no Hisai e no Kuni no Taio ni tsuite (Recommendations based on the administrative verification and monitoring results of nuclear disaster prevention operations [#1]: How the national government deals with a nuclear power plant damaged by a large-scale earthquake)," February 2008. Accessed June 22, 2012, warp.ndl.go.jp/info:ndljp/pid/283520/www.soumu.go.jp/s-news/2008/pdf/080201_1_2.pdf.
Page 5 of the report describes how "nuclear power plants could be damaged by operational accidents or troubles (accidents triggered by staff) as well as external factors including a large-scale earthquake." The description seems to indicate that there could be a cause-and-effect relationship between a large-scale earthquake and a nuclear disaster.

[125] Earthquake-resistant measures implemented at important nuclear power plant facilities were planned based on the experience at the Kashiwazaki-Kariwa Nuclear Power Plant managed by TEPCO. At the time of the Niigata-ken Chuetsu-oki Earthquake, the central processing facility of the plant to transmit radioactivity data measured through monitoring posts and other devices to the Internet and other networks jolted horizontally, triggering a loose connection on cable connectors and disabling data transmission.

[126] METI, "Sogo Shigen Enerugi Chosakai Genshiryoku Anzen, Hoan Bukai Genshiryoku Bosai Sho-Iinkai Dai 15kai Haifu Shiryou 'Jigyosha ni okeru Joho Renraku ni kansuru Akushon Puran e no Torikumi Jokyo Ichiran (Heisei 20nen 9gatsu 30nichi Matome)' (Status of the action plan implemented by the nuclear operators for information sharing [as of September 30, 2008])," a material presented at the 15th meeting, the Nuclear Disaster Prevention Subcommittee of the Nuclear and Industrial Safety Subcommittee of the Advisory Committee for Natural Resources and Energy [in Japanese]. Accessed June 22, 2012, www.meti.go.jp/committee/materials2/downloadfiles/g81006b07j.pdf.

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. [127]

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

[127] This section is based on comments by Yuhei Sato, Governor of Fukushima Prefecture, at the 17th NAIIC Commission meeting, and other hearings with related persons and documents from NISA and the Fukushima prefectural government.

hours.[128] 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. [129]

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*

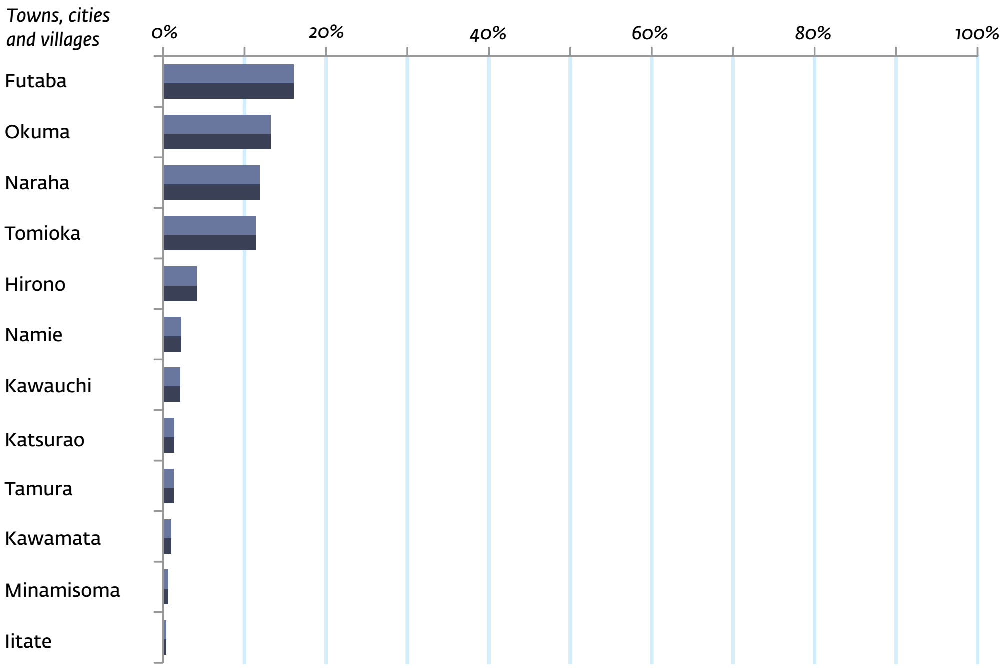
Emergency preparedness drills do not merely allow participants to actually experience evacuation or obtain related knowledge. Repeating effective drills is critical in enabling participants to discover new practical concerns, and improve their preparedness for unexpected events and emergency situations.

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 Figure 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.

[128] Director-General for Policy Planning of Cabinet Office (in charge of disaster prevention) reporting to Assistant Chief Cabinet Secretary of Cabinet Office (in charge of security and crisis management), et al. "Heisei 20nendo Genshiryoku Sogo Bosai Kunren Jisshi Yoryo (FY2008 comprehensive nuclear emergency preparedness drill implementation plan)," 51 [in Japanese]. Accessed June 22, 2012, www.meti.go.jp/committee/materials2/downloadfiles/g81006b02j.pdf.

[129] Director-General for Policy Planning of Cabinet Office (in charge of disaster prevention) reporting to Assistant Chief Cabinet Secretary of Cabinet Office (in charge of security and crisis management), et al. "Heisei 20nendo Genshiryoku Sogo Bosai Kunren Hokokusho (FY2008 comprehensive nuclear emergency preparedness drill report)," 7 [in Japanese]. Accessed June 22, 2012, www.meti.go.jp/committee/materials2/downloadfiles/g90427c11j.pdf.

Figure 4.3.3-1: Ratio of local residents receiving evacuation drills before the accident (against all evacuated residents)



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. [130]

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.

[130] This section is based on Haruki Madarame, NSC Chairman, at the 4th NAIIC Commission meeting, Yukio Edano, former Chief Cabinet Secretary, at the 15th NAIIC Commission meeting, Yuhei Sato, Governor of Fukushima Prefecture, at the 17th NAIIC Commission meeting, hearing with Goshi Hosono, former Special Advisor to the Prime Minister, hearings with related persons and documents (both related persons and documents from the Nuclear and Industrial Safety Agency [NISA], the Nuclear Safety Commission [NSC], the Cabinet Secretariat, the Ministry of Economy, Trade and Industry [METI], the Ministry of Education, Culture, Sports, Science and Technology [MEXT], the Japan Nuclear Energy Safety Organization [JNES], the Japan Atomic Energy Agency [JAEA], the Nuclear Safety Technology Center [NUSTEC], and the Fukushima prefectural government).

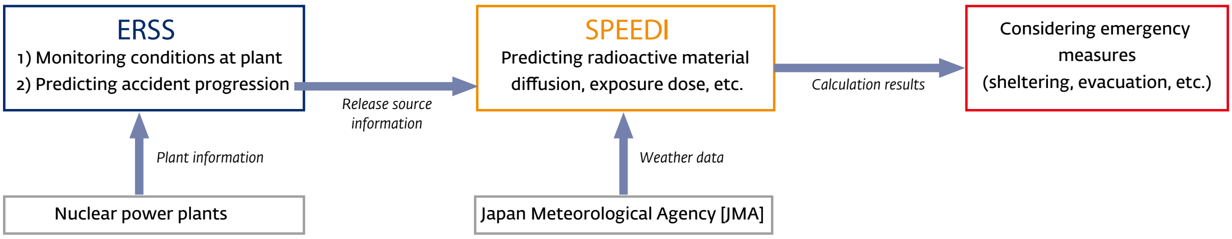


Figure 4.3.4-1: Outline of the coordination between ERSS and SPEEDI

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.[131] 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 ERSS-calculated 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

[131] "The Regulatory Guide: Emergency Preparedness for Nuclear Facilities" placed SPEEDI in a position of importance, stipulating, "It is important to establish the SPEEDI network system, which can swiftly predict the impact of radiation by inputting weather information and released source term information, ERSS, which can conduct predictions on the state of facilities based upon information on operation of facilities or other type of information sent from nuclear operators, and so on."

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.

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

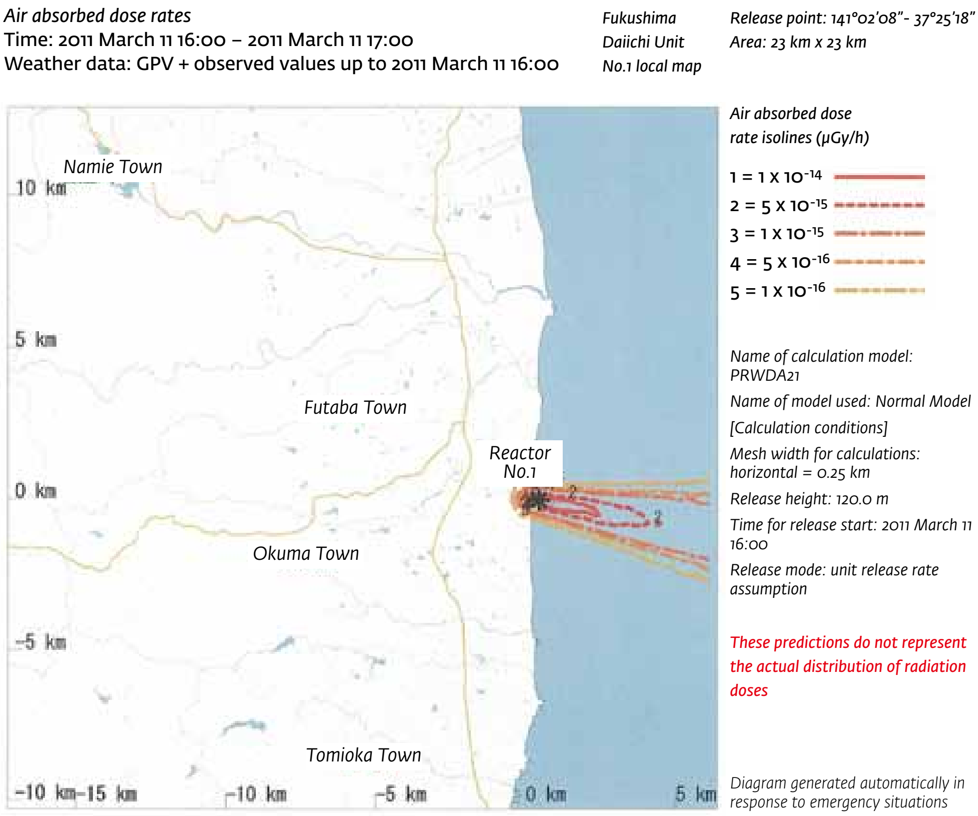
Because release source information was not available from ERSS at the time of the accident, prediction calculations, etc. were initially conducted with SPEEDI using release information for unit release rate assumption and release source information predicted on the basis of the results of the analysis 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. [132]

[132] The assumed values used as release source information included, for example, (i) data on the postulated amount released at the time of a hypothetical accident and serious accident included in the application for permission of the plant's establishment, (ii) total radiation dose rate within the reactor included in the application document for permission of the plant's establishment, (iii) prediction data for amount released at the time of accident preserved in the ERSS database, etc. The persons in charge at MEXT and at NISA-ERC conducted 38 and 45 calculations, respectively.

Figure 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) [133]



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 diffu-

[133] MEXT, "Kinkyuji Jinsoku Hoshano Eikyo Yosoku Nettowaku Shisutemu (SPEEDI) Tanniryo Hoshutsu wo Katei shita Yosoku Keisan Kekka (System for Prediction of Environmental Emergency Dose Information (SPEEDI): Predictive Calculation Results Using Assumptions for Unit Release Rate Assumption)," 2011 [in Japanese]. Accessed June 22, 2012, www.bousai.ne.jp/speedi/20110311rok/201103111600.pdf.

sion 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.

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,[134] 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. [135]

4. *Assessment of the functions and potential for utilization of the prediction systems*

ERSS and SPEEDI are essentially systems to calculate predictions of future events using specific calculation models. There are situations in which SPEEDI can be used, but during this accident, it could not be supplemented with environmental radiation monitoring, and was not utilized for evacuation orders in the initial response. There is a serious problem with the posture of the relevant organizations, which did not compensate for the limitations of the prediction systems.

a. Limitations of the functions of ERSS

As explained in 1a., ERSS is a system that analyzes the future progression of an accident based on information from the plant, etc. and conducts predictive calculations for release source information. However, as we mentioned in 2, there is a limitation in the release source information calculated with ERSS in that it contains a certain level of uncertainty, since the reliability of the analysis code for ERSS to predict the amount of emissions of radioactive material from the plant containment is not high.

In the case of this accident, plant information was unavailable, so the predictions by

[134] In Fukushima Prefecture, a SPEEDI terminal was installed in the Nuclear Safety Division on the eighth floor of the West Wing of the Prefectural Office, but it was impossible to receive transmissions there immediately after the earthquake occurred because telecommunication lines had been cut. It was arranged on the request of the Fukushima Prefecture Headquarters for Disaster Control to have NUSTEC send the results of the predictive calculations with SPEEDI by email.

[135] The Fukushima Prefecture Headquarters for Disaster Control, "Fukushima Daiichi Genshiryoku Hatsudensho Jiko Hassei Tosho no Denshi meru ni yoru SPEEDI Shisan Kekka no Toriatsukai Jokyo no Kakunin Kekka ni tsuite (Regarding the Results of Confirmation of How the SPEEDI Calculation Results Were Handled during the Initial Stages after the Occurrence of the Fukushima Daiichi Nuclear Power Plant Accident)," April 20, 2012 [in Japanese]. Accessed June 22, 2012, www.pref.fukushima.jp/nuclear/info/120420.html.

ERSS on the progression of the accident were conducted on the basis of typical accident postulates entered into the database prior to the event. This made the release source information even more uncertain than in a case where plant information is available.

b. Limitations of the functions of SPEEDI

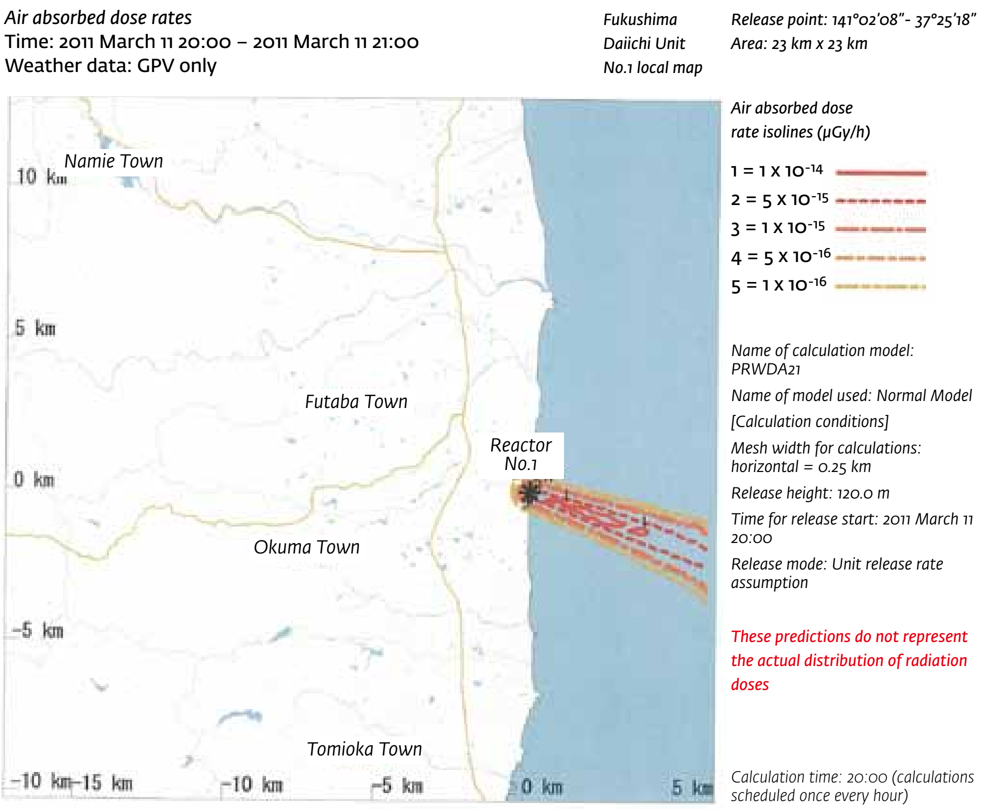
As explained in 1b., the values used for predictive calculations with SPEEDI consist of (i) the results of predictive calculations from ERSS, (ii) unit release rate assumption (1Bq/h), and (iii) other assumed values. However, the results of calculations from ERSS contain uncertainty as explained in 4. a., while (ii) and (iii) are merely assumed values in the first place, and the period to provide the assumptions for the calculations for the basis of decisions on evacuation and sheltering is unclear in the case where the timing of large amounts of radioactive material being released is unclear. There is a certain level of accuracy in predictions that could be used for making of temporary evacuation decisions for short periods of time when the wind direction is stable, but it would be difficult to decide long-term evacuation orders on the basis of predictive calculations.

The weather forecast information used for calculating predictions has limitations, particularly with regard to localized rainfall, snowfall, etc. It is also difficult as a practical matter to issue orders regarding the direction of evacuation that reflect ever-changing weather information.

The SPEEDI prediction results are not highly accurate, particularly in cases where release source information from ERSS is not obtainable, so it is not by itself accurate enough to serve as the basis for establishing evacuation areas in the initial response.

For reference purposes, Figure 4.3.4-3 represents the results of SPEEDI predictive calculations just before evacuation orders were issued for a radius of 3km from the Fukushima Daiichi Nuclear Power Plant, Figure 4.3.4-4 represents the results just before evacuation orders were issued for a radius of 10km, and Figure 4.3.4-5 repre-

Figure 4.3.4-3: Diagram of predictive calculations with SPEEDI using unit release rate assumption (predictions for air absorbed dose rates, March 11 20:00-21:00) [136]



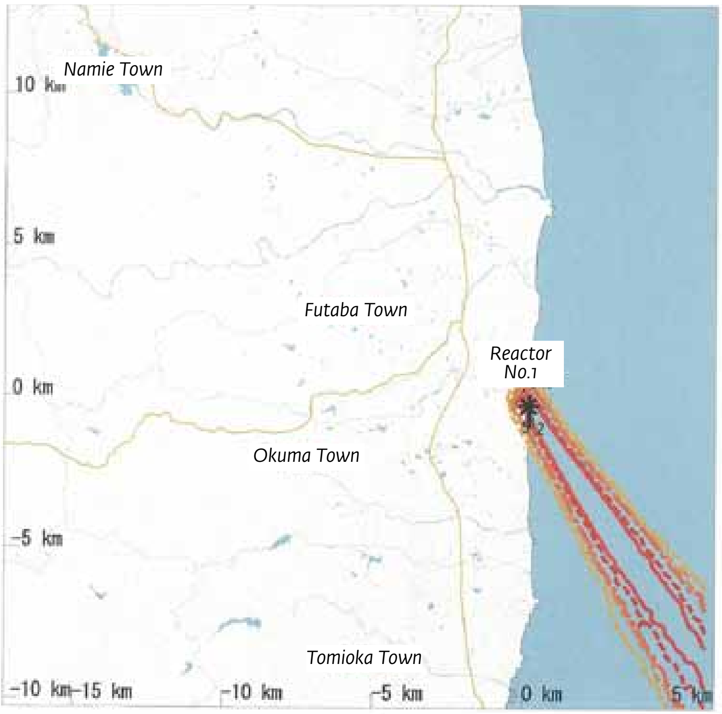
[136] MEXT, "Kinkyuji Jinsoku Hoshano Eikyo Yosoku Nettowaku Shisutemu 'SPEEDI' Tanniryo Hoshutsu wo Katei shita Yosoku Keisan Kekka (System for Prediction of Environmental Emergency Dose Information [SPEEDI]: Predictive Calculation Results Using Unit Release Rate Assumption)," 2011 [in Japanese]. Accessed June 22, 2012, www.bousai.ne.jp/speedi/20110311rok/201103112000.pdf.

Figure 4.3.4-4: Diagram of predictive calculations with SPEEDI using unit release rate assumption (predictions for air absorbed dose rates, March 12 05:00-06:00) [137]

Air absorbed dose rates
Time: 2011 March 12 05:00 – 2011 March 12 06:00
Weather data:

Fukushima Daiichi Unit No.1 local map

Release point: 141°02'08"- 37°25'18"
Area: 23 km x 23 km



Air absorbed dose rate isolines (μGy/h)
1 = 1 x 10^{-14}
2 = 5 x 10^{-15}
3 = 1 x 10^{-15}
4 = 5 x 10^{-16}
5 = 1 x 10^{-16}

Name of calculation model: PRWDA21
Name of model used: Normal Model
[Calculation conditions]
Mesh width for calculations: horizontal = 0.25 km
Release height: 120.0 m
Time for release start: 2011 March 12 05:00
Release mode: unit release rate assumption

These predictions do not represent the actual distribution of radiation doses

Calculation time: 05:00 (calculations scheduled once every hour)

Figure 4.3.4-5: Diagram of predictive calculations with SPEEDI using unit release rate assumption (predictions for air absorbed dose rates, March 12 18:00-19:00) [138]

Air absorbed dose rates
Time: 2011 March 12 18:00 – 2011 March 12 19:00
Weather data:

Fukushima Daiichi Unit No.1 local map

Release point: 141°02'08"- 37°25'18"
Area: 23 km x 23 km

Air absorbed dose rate isolines (μGy/h)
1 = 1 x 10^{-14}
2 = 5 x 10^{-15}
3 = 1 x 10^{-15}
4 = 5 x 10^{-16}
5 = 1 x 10^{-16}

Name of calculation model: PRWDA21
Name of model used: Normal Model
[Calculation conditions]
Mesh width for calculations: horizontal = 0.25 km
Release height: 120.0 m
Time for release start: 2011 March 12 18:00
Release mode: Unit release rate assumption

These predictions do not represent the actual distribution of radiation doses

Calculation time: 18:00 (calculations scheduled once every hour)

[137] MEXT, "Kinkyuji Jinsoku Hoshano Eikyo Yosoku Nettowaku Shisutemu 'SPEEDI' Tanniryo Hoshutsu wo Katei shita Yosoku Keisan Kekka (System for Prediction of Environmental Emergency Dose Information [SPEEDI]: Predictive Calculation Results Using Unit Release Rate Assumption)," 2011 [in Japanese]. Accessed June 22, 2012, www.bousai.ne.jp/speedi/20110311rok/201103112000.pdf.

[138] MEXT, "Kinkyuji Jinsoku Hoshano Eikyo Yosoku Nettowaku Shisutemu 'SPEEDI' Tanniryo Hoshutsu wo Katei shita Yosoku Keisan Kekka (System for Prediction of Environmental Emergency Dose Information [SPEEDI]: Predictive Calculation Results Using Unit Release Rate Assumption)," 2011 [in Japanese]. Accessed June 22, 2012, www.bousai.ne.jp/speedi/20110311rok/201103112000.pdf.

sents the results just before evacuation orders were issued for a radius of 20km.

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 better-informed 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.

d. The need to establish a network for environmental radiation monitoring

As explained in 2a., the Monitoring Guideline also assumed that the consideration of protective action for residents would not rely solely on the SPEEDI results, but would be conducted by comprehensively combining them with the results of the environmental radioactivity monitoring. Particularly in a case like this accident, where release source information from ERSS could not be obtained and the reliability of the SPEEDI results was low, it is extremely important to obtain the results of environmental radiation monitoring swiftly and from over a wide area.

During this accident, it was impossible to obtain almost any emergency monitoring results during the initial response stage because the monitoring posts, which were overly concentrated along the Fukushima Prefectural coastline, became unusable in the wake of the earthquake and tsunami.

Until the accident, MEXT had contended that the SPEEDI system would be useful in determining evacuation orders during emergencies, and it spent approximately 12 billion yen in government funds through FY2010. Yet it had not moved forward sufficiently in establishing a wide range and large number of monitoring posts. The postures of MEXT, which had spent a large amount of government funds on the development and operation of SPEEDI, yet had failed to undertake sufficient measures to compensate for its limitations – as well as NISA and NSC, which had detected the limitations of SPEEDI yet had let this go by – is a major problem.

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.

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.

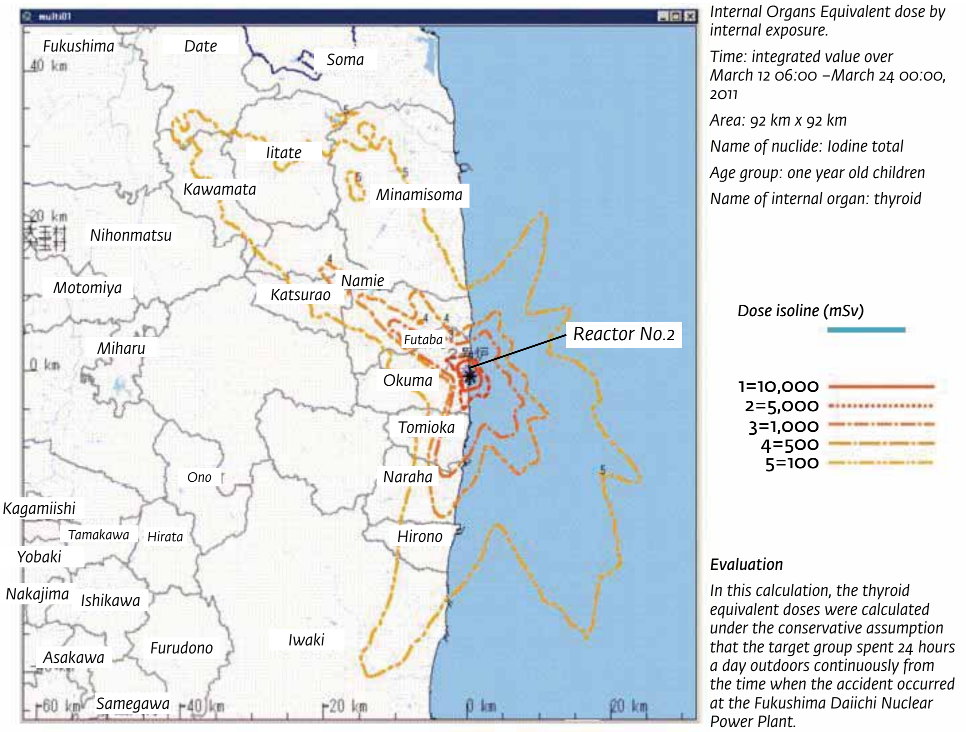
From April 26 on, also under orders from Edano, each of the relevant ministries and agencies disclosed SPEEDI results. However, the disclosures of the results were conducted separately by NSC, NISA and MEXT, and some confusion resulted, such as in the case where Special Advisor to the Prime Minister 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

Figure 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) [139]



to the accident.

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:

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

[139] NSC, "Kinkyuji Jinsoku Hoshano Eikyo Yosoku Nettowaku Shisutemu 'SPEEDI' no Shisan ni tsuite (Regarding Calculations with the System for Prediction of Environmental Emergency Dose Information 'SPEEDI')," March 23, 2011 [in Japanese]. Accessed June 22, 2012, www.nsc.go.jp/info/110323_top_siryo.pdf.

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.)

4.3.5 Flaws in the radiation emergency medicine network

1. *Role of the radiation emergency medicine network*

Radiation emergency medicine refers to medical treatment provided in the event of contamination and radiation exposure as a result of radiation accidents and nuclear disasters. The medical institutions that provide special treatment to patients suffering from radiation contamination or exposure are known as radiation emergency medical institutions. Several of the medical institutions located in prefectures where nuclear power plants are situated have been designated as radiation emergency medical institutions and, together with the National Institute of Radiological Sciences, make up the radiation emergency medicine network.

The radiation emergency medicine network was reviewed in 1999 following the JCO accident. However, the review only took into consideration the scale of the JCO accident, and the resulting network was not one that could respond to a large-scale emission of radioactive substances, as in the case of a nuclear power plant disaster.

According to the basic principles underlying "The Shape of Radiation Emergency Medicine"[140] agreement drawn up by NSC in relation to the radiation emergency medicine network, "A radiation emergency medicine network [is required to be] a 'safety net' for nuclear power, protecting the lives and health of people under abnormal circumstances." The national government, local governments, nuclear power operators, and medical personnel put their best into building up, maintaining, and developing the radiation emergency medicine network, based on the principles of emergency and disaster medicine, and from the perspective of life that "anyone can receive the best medical treatment anywhere, at anytime."

A total of 59 hospitals nationwide have been designated as initial radiation emergency medical hospitals by the local governments, and their role is to "provide initial medical treatment for all victims that are brought into the hospital, even victims that are not contaminated in the vicinity of nuclear power facilities. This includes treatment of sicknesses that would ordinarily be treated in the emergency room."[141] Specifically, these institutions make use of survey meters and other equipment to measure radiation levels for patients. In the event patients are found to be contaminated, they are wiped down and given iodine, in addition to other emergency treatment they may receive.

When a primary radiation medical hospital is unable to treat a patient due to the patient's exposure to high radiation levels or other reasons, the patient is transferred to a secondary radiation medical hospital. The secondary radiation medical hospital is situated in a "location that allows for the transportation of the patient from the nuclear facility or the primary radiation medical hospital in a relatively short time, using an appropriate means of transportation."[142] There, the degree of internal contamination is measured, and his or her body is decontaminated in a shower. When necessary, the victim can also be admitted into the hospital for further treatment.

The National Institute of Radiological Sciences has been designated as the tertiary radiation medical hospital in East Japan, while Hiroshima University has been designated as the hospital in West Japan. Seriously irradiated patients that cannot be treated at the

[140] NSC, "Kinkyu Hibaku Iryo no Arikata ni tsuite (The Shape of Radiation Emergency Medicine)," June 2001, Revised partially in October 2008 [in Japanese].

[141] NSC, "Kinkyu Hibaku Iryo no Arikata ni tsuite (The Shape of Radiation Emergency Medicine)," June 2001, Revised partially in October 2008 [in Japanese].

[142] NSC, "Kinkyu Hibaku Iryo no Arikata ni tsuite (The Shape of Radiation Emergency Medicine)," June 2001, Revised partially in October 2008 [in Japanese].

primary and secondary radiation medical hospitals have their radiation doses assessed at the tertiary radiation medical hospital and appropriate medical treatment is provided, depending on the types of nuclides.

2. *Problems with the location and number of patients that can be hospitalized*

The radiation emergency medicine network is the result of considerations made after the JCO accident. The network includes countermeasures that were formulated based on assumptions of an accident similar in scale to the JCO accident, but does not take into account accidents that cause the diffusion of radioactive substances over a wide area. For that reason, one condition for the designation of a primary radiation medical hospital is close proximity to nuclear facilities, in order to facilitate a prompt response to patients suffering from injuries, illnesses, and/or contamination in the nuclear facilities. Hospitals that are located close to nuclear power plants are designated as primary radiation medical hospitals. There is a possibility that such hospitals may fall under the evacuation area during a nuclear accident such as the Fukushima power plant disaster.

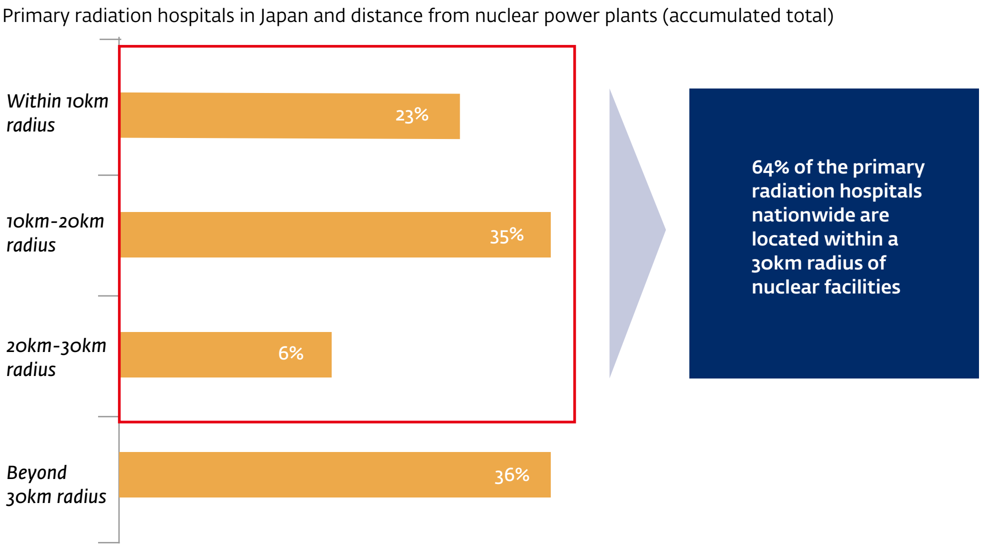
At the majority of the primary and secondary radiation medical hospitals, the upper limit of the number of patients that can be hospitalized is only one or two. It is clear that radiation emergency medical hospitals would be unable to cope in the event of a large number of residents being exposed to radiation.

a. Problems with the location of primary radiation hospitals

One of the requirements for radiation emergency hospitals [143] is that they "facilitate easy transportation of patients from nuclear facilities and to other radiation emergency hospitals (transportation route, distance, and time)"[144] in addition to their ability to provide emergency and disaster treatment. Primary radiation hospitals are designated in consideration of their proximity to nuclear facilities. [145]

There are six hospitals that serve as primary radiation medical facilities in Fukushima: Minamisoma City General Hospital (Minamisoma City), Futaba Kosei Hospital (Futaba Town), Fukushima Prefectural Ono Hospital (Okuma Town), Imamura Hospital (Tomioka Town), Iwaki Kyoritsu General Hospital (Iwaki City), and Fukushima Rosai Hospital (Iwaki City). Of these, Futaba Kosei Hospital, Fukushima Prefectural Ono Hospital, and Imamura Hospital lie within the 10km radius zone of the Fukushima Daiichi Nuclear Power Plant, while Minamisoma City General Hospital is located within the 30km radius zone. All patients had to evacuate from these hospitals. The

Figure 4.3.5-1: Locations of the primary radiation hospitals [146]



[143] Five requirements are described for the desirable hospitals to prepare for the radiation emergency medicine. NSC, "Kinkyu Hibaku Iryo no Arikata ni tsuite (The Shape of Radiation Emergency Medicine)," June 2001, Revised partially in October 2008 [in Japanese].

[144] NSC, "Kinkyu Hibaku Iryo no Arikata ni tsuite (The Shape of Radiation Emergency Medicine)," June 2001, Revised partially in October 2008 [in Japanese].

[145] Hearing with the National Institute of Radiological Sciences

[146] Complied by NAIIC

remaining two hospitals were also damaged in the earthquake and tsunami, and had their water supplies cut off. They were thus unable to carry out normal hospital operations. Needless to say, they were also unable to provide radiation emergency medicine.

Of the 59 primary radiation hospitals all over Japan, more than 60 percent are located within a 30km radius of a nuclear power plant. If there is another disaster like Fukushima that involves an earthquake, tsunami and a nuclear power plant, accident there are concerns that many of the primary radiation hospitals will similarly be unable to function. (See Figure 4.3.5-1.)

b. Number of patients that can be hospitalized

(i) Primary and secondary radiation emergency hospitals

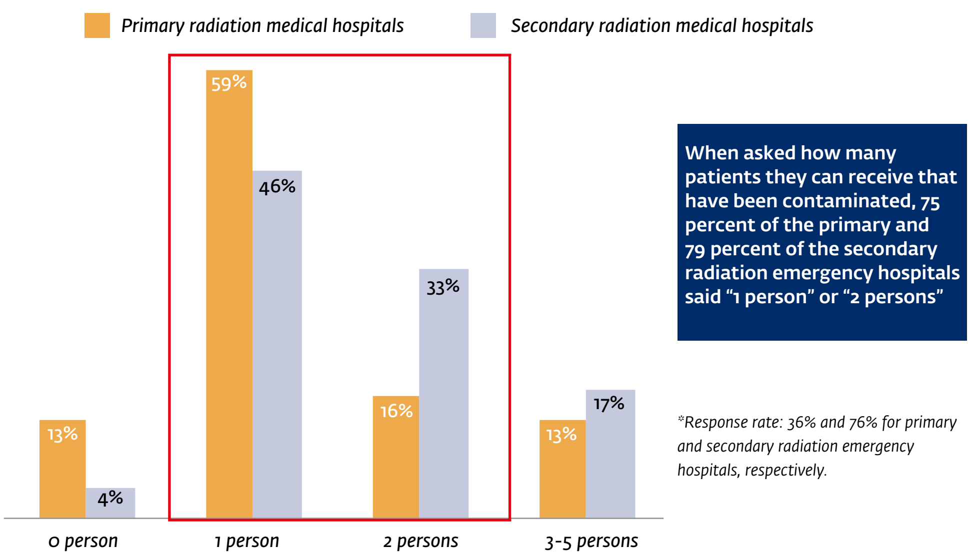
According to a survey conducted by the NSC in 2010, 75 percent of the hospitals designated as primary radiation emergency hospitals were only able to take in one or two patients and perform only primary care such as wiping off contamination. When asked the question, "If there is a number of patients suffering from contamination, will your hospital be able to receive these patients in general wards after decontamination?" approximately half of the hospitals replied "Yes."

Out of the 34 hospitals designated as secondary radiation emergency hospitals, 26 responded to the survey. The percentage of hospitals that can receive a maximum of one or two patients each time was 79 percent (refer to Figure 4.3.5-2). When asked the question "If there is a number of patients suffering from contamination, will your hospital be able to receive these patients in general wards after decontamination?" approximately 60 percent replied "Yes" .

(ii) Tertiary radiation emergency hospitals

The National Institute of Radiological Sciences, which has been designated as the tertiary radiation emergency hospital for East Japan, can hospitalize four critically ill patients and 10 patients with mild symptoms. In the event that the number of patients exceeds the capacity of the hospital, patients will be sent to partner hospitals after

Figure 4.3.5-2: Maximum number of patients that can be received by primary and secondary radiation medical hospitals [147]



they have been given emergency treatment. The National Institute of Radiological Sciences has eight partner hospitals, and each hospital is able to receive a maximum of two patients. The capacity of Hiroshima University Hospital, which has been designated as the tertiary radiation emergency hospital for West Japan, is 10 critically ill patients and 11 patients that require medium care. This capacity is the combined capacity for Hiroshima University Hospital and its partner hospitals. Currently Hiroshima University has no decontamination facility for radiation emergency medical treatment. Such a facility is scheduled to be completed in 2012.

[147] Complied by NAIIC

3. *Problems pertaining to inadequate decontamination facilities and radiation training for hospital staff*

Within the radiation emergency medical network, one of the problems that surfaced in the aftermath of the Fukushima accident was the lack of decontamination facilities. The organization that played a central role in decontaminating residents with low dose exposure was not the radiation emergency medical network, but the Self-Defence Forces.

A second problem with radiation emergency hospitals that surfaced in this accident was the inadequacy in radiation training for hospital staff working in these hospitals. Some of the patients were workers who may have been exposed to high doses of radiation as they tried to contain the radiation leakage at the plant. Confusion arose in the radiation emergency hospitals in Fukushima prefecture that received these patients, as the hospital staff did not have sufficient knowledge about radiation and radioactive materials. Although these radiation emergency hospitals take part in seminars and training sessions at the National Institute of Radiological Sciences with the aim of imparting accurate knowledge about radiation and prevention measures, the hospital staff who participated in these training programs generally took a passive attitude toward the training, and the number of participants for each seminar has seen sluggish growth.

a. Inadequate decontamination facilities

The number of contaminated patients that can be received by radiation emergency hospitals is low, and the hospitals do not act on the premise that a large number of residents could become contaminated. In this accident, although the primary radiation emergency hospitals were located in Minamisoma City and Iwaki City in areas more than 20km from the nuclear power plants, they were similarly not equipped with decontamination facilities that could handle a large number of patients. The decontamination of residents was carried out instead at temporary decontamination tents set up by the Self-Defence Forces.

In addition, some of the workers and SDF personnel at the site who were involved in the containment of this accident were exposed to high doses and required decontamination. These patients had to undergo treatment at specialized radiation medical hospitals in order to have their radiation doses assessed and be decontaminated. According to a hearing[148] conducted on the medical squad of the Local NERHQ at the Off-site Center, many patients suspected of having been exposed to high doses of radiation were transported to the Off-site Center. Upon their arrival however, not enough medical equipment was available to the doctors. It became necessary to transport these patients to primary or secondary radiation emergency hospitals. Due to the impact of the earthquake and tsunami, many of the hospitals in the prefecture had been damaged and had no running water or other basic infrastructure. The Fukushima Medical University Hospital was the only radiation emergency hospital that could receive patients, and even so, the number of patients it could decontaminate at one time was limited to several persons.

b. Confusion among hospital staff due to inadequate knowledge about radiation

At the Fukushima Medical University Hospital, a secondary radiation emergency hospital, water supplies had been cut off as a result of the earthquake, and it was difficult to secure water for decontamination. The hospital was cautious in receiving patients suspected of suffering from radiation contamination immediately after the accident. Among the hospital staff, there were doctors and nurses who left the hospital out of fear of radiation from contaminated patients.[149] In order to allay the anxiety among its staff, the hospital invited radiation specialists to the hospital immediately after the accident to discuss the dangers of radiation with hospital staff. In addition, the top management of the hospital discussed the hospital's response to the situation with specialists, and thereby succeeded in developing a system for receiving such patients.

The hesitance shown by these general hospitals toward the reception of contami-

[148] Hearing with the medical squad of the Local NERHQ

[149] Hearing with Fukushima Medical University Hospital personnel

nated patients, despite their designation as radiation emergency hospitals, is a result of inadequate knowledge about radiation among its staff, including doctors, nurses, and administrative personnel. The excessive anxiety of the staff was one of the factors behind this hesitance to receive contaminated patients.

c. Inadequate training of radiation emergency hospital staff with regard to radiation

In order to prevent such situations, the medical staff of radiation emergency hospitals is expected to work toward maintaining and improving radiation medical treatment standards by regularly participating in seminars and training sessions. This, however, is not mandatory for any doctor in Japan, and even those working at radiation emergency hospitals are not required to attend emergency radiation medical training. As most hospitals in Japan have a high turnover rate for doctors, the doctors who do receive radiation treatment training generally move to other hospitals. A conducive

Table 4.3.5-1: Annual number of participants in seminars organized by the National Institute of Radiological Sciences [150]

Training program		Period	Primary radiation emergency hospital	Secondary radiation emergency hospital
NIRS radiation accident Initial response seminar	First session	February 8 to 10, 2010	0	0
	Second session	December 13 to 15, 2010	0	0
	Third session	July 6 to 8, 2011	0	0
	Fourth session	December 6 to 8, 2011	0	0
	Total		0	0
NIRS radiation treatment seminar	First session	November 18 to 20, 2009	0	1
	Second session	September 27 to 29, 2010	0	2
	Third session	October 12 to 14, 2011	1	1
	Fourth session	December 14 to 16, 2011	1	0
	Total		2	4
Emergency radiation medical treatment instructor training course	First session	September 7 to 9, 2011	1	2
	Total		1	2

environment does not exist for enticing doctors trained in the treatment of patients contaminated with radioactive materials to stay in these hospitals.

Only two doctors from all the primary radiation emergency hospitals in Japan have participated in the "NIRS Radiation Treatment Seminar" organized by the National Institute of Radiological Sciences from 2009 to the end of 2011, and only four doctors from secondary radiation emergency hospitals. The number of places available for this period was 100, so this is extremely low. (See Table 4.3.5-1.) Although lecturers were dispatched to each hospital from the Nuclear Safety Research Association to conduct seminars, the management staff of the radiation emergency hospitals within Fukushima prefecture were of the opinion that it was difficult to have doctors continue to participate in such training sessions given the shortage in the number of doctors at these facilities and the doctors there were already overworked. They were also believed the content of the monthly seminars was basically repeated every month, and so the sessions were only a ritual. The overall attitude toward these training programs was passive. [151]

It is clear that the current emergency radiation medical system is unable to deal with accidents similar to the Fukushima disaster that involve the release of large amounts of radioactive substances over a wide area. The following problems were made clear through this survey: inappropriate locations of primary radiation emer-

[150] Complied by NAIIC

[151] Hearing with medical institutions in Fukushima Prefecture

[152] NSC, "Kinkyu Hibaku Iryo no Arikata ni tsuite (The Shape of Radiation Emergency Medicine)," June 2001, Revised partially in October 2008, 3 [in Japanese].

gency hospitals as the hospitals themselves had to be evacuated; the inability of these hospitals to treat any patients; the lack of decontamination facilities; and finally, the inadequate or almost non-existent radiation training of the hospital staff. In order to resolve these issues, it is important to develop counter-radiation measures in ordinary circumstances. If not, under circumstances similar to the recent accident, it is impossible to achieve the basic principle promulgated by the NSC[152]—"The emergency radiation medical system is a 'safety net' for nuclear power, protecting the lives and health of people under abnormal circumstances."

4.4 The health effects of radiation: current and future prospects

The impact of radiation on health is one of the most important concerns of the people of Japan. The national and Fukushima prefectural governments have not fully responded to the residents' ongoing doubt, namely, "how much radiation have my family and I been exposed to, and how much does that affect our health?" Many are confused by the insufficient and vague explanations from the national and Fukushima prefectural governments.

It is known from epidemiological studies of the Hiroshima and Nagasaki atomic bomb survivors that radiation exposure entails the risk of cancer. It is necessary to monitor both internal and external doses and to take measures to reduce all sources of radiation, taking age and gender into consideration. After the Fukushima disaster, the Nuclear Emergency Response Headquarters (NERHQ) and the prefectural governor failed to issue dosing instruction of iodine tablets to the residents that could have protected them from exposure to radioactive iodine.

In order to decrease the radiation exposure level of the residents, it will be necessary to restrict the ingestion of food products contaminated by radioactive material and to continuously measure the internal exposure dose over the medium and long term. However, the national and the Fukushima prefectural governments seem to be unable and unwilling to gather information on the internal exposure dose from radioactive cesium.

Before the accident, TEPCO had not considered measures to ensure workers' safety during a severe accident. Their response immediately after the accident was equally inadequate. They failed, for example, to provide information to the workers regarding the amount of environmental radiation in the area. They also failed to properly manage the workers' individual radiation exposure dose, and conducted dose management for multiple workers as a group by limited numbers of dosimeter. Exposure countermeasures for workers at nuclear power plants are important in securing the safety of the residents as well. Securing the safety of workers responding to accidents will always be important.

Radiation is not the only cause of health problems from a disaster of this scale. After the Chernobyl nuclear accident, the impact on public mental health became a major social challenge. The Commission believes that the physical and mental health of the residents is an important priority, and that measures should be taken quickly to ensure the total well-being of all affected.

4.4.1 The impact of radiation on health

1. *Acute and late radiation effects*

Radiation penetrates the body and injures cells in its path because of its large amount of energy. The amount of energy that connects all the molecules in the body of a living organism is vastly smaller than the energy of radiation (which is approximately 10-5 of the beta radiation from cesium 137, for example). Because of this, when even a single ray of radiation passes through a cell, the connections within the molecules in its path are easily broken, and their functions are impaired. Radiation may sever DNA, the blueprint of the body, because the pathways of radiation are random.

DNA does have self-repair functions. However, when it is exposed to large amounts of radiation, the number of breaks increases, and if repairs are not made in time the cell will die. When the entire body is exposed to a large amount of radiation at once, acute radiation injury occurs. The symptoms vary according to exposure dose. In cases where the exposure is low, the symptoms will be limited to low lymphocyte and leukocyte counts, nausea, fever, diarrhea, and the like; when the exposure is high, rectal bleeding, purpura (purple discolorations of the skin), alopecia (hair loss) and the like may occur, in some cases leading to death.

Fortunately, there have not been any reports of serious acute radiation injury during the course of this accident. Acute radiation injury has a definite effect, and occurs when exposure goes above a certain level. The boundary for the level of dose below which acute radiation injury does not occur is known as the "threshold dose." This depends on the symptoms, but it is generally considered to be between 100 and 250 mSv.

In the case of low-dose radiation exposure (100 mSv or lower),[153] there is a possibility that late effects such as leukemia and/or genetic disorders may occur years or decades later. Late effects appear with a certain probability, such that "x" out of a number of people who are exposed will be affected. This is also known as the stochastic effect. The reason that radiation is a cause of carcinogenesis is that it inflicts complicated damage on DNA.

DNA damage occurs routinely from a variety of causes, but the cell can repair most of it. However, because radiation carries an enormous amount of energy, the damage is complicated and therefore difficult to repair, and the repairs are error-prone. If there is an error in the repair, a point mutation occurs in the gene at that spot. Since a mutation cannot be reversed, it will remain as long as that cell lives, and will be inherited by the daughter cells when that cell divides. When the cell carrying the mutation is exposed to more radiation and there is an error in repairing the damage, another gene will undergo mutation. Thus, mutations can accumulate within a cell, in some cases causing cancer. In other words, radiation risk accumulates.

Workers who are exposed to radiation calculate their exposure dose using dosimeters as a means of protection so that they can know their total doses and avoid excessive exposure. After an accident, the purpose of decontamination, placing limits on the amount of radioactivity in food and drink and evacuating areas contaminated by radioactive material is to keep additional exposure as low as possible and thus prevent the risk from increasing. Even if there has been exposure to radiation, the overall future risk can be reduced if there is little additional exposure.

2. *Dose and carcinogenic risk*

The environmental radiation dose increased rapidly on March 15, after the hydrogen explosions at the Fukushima Daiichi plant. Radioactive plumes containing high concentrations of radioactive iodine, cesium 134, cesium 137, etc. were carried by the wind, and the residents ingested this radiation through respiration and drinking water. It became clear after the Chernobyl nuclear accident that radioactive iodine accumulates in the thyroid gland and causes thyroid cancer. Iodine tablets need to be ingested to prevent this, but only a very small number of residents in the surrounding area took them.

The relationship between radiation dose and carcinogenesis has been the subject of epidemiological research. The life span study of the Hiroshima-Nagasaki atomic bombing survivors[154] is considered worldwide to be one of the most reliable studies available. It tracked 86,611 people exposed to radiation (average dose 200 mSv, 50 percent or more exposed to 50 mSv or less) for 53 years, beginning in 1950. For all solid cancers, excluding leukemia, the number of cancer deaths increased linearly in proportion to dose. Although cancers did occur at doses of 100 mSv or less, they were not statistically significant, and it is currently considered difficult to prove a connection using only epidemiological methods.

Assuming that carcinogenic risk cannot be proven epidemiologically at doses of 100 mSv or less, is there a way to know if there is a risk? Five models have been devised to estimate the risks for the unknown effects of radiation (see Figure 4.4.4-1).[155] The one that ICRP opted for is (a) in Figure 4.4.1-1, a linear no-threshold (LNT) model. In other words, there is no recognized "threshold" below which one is safe with regard

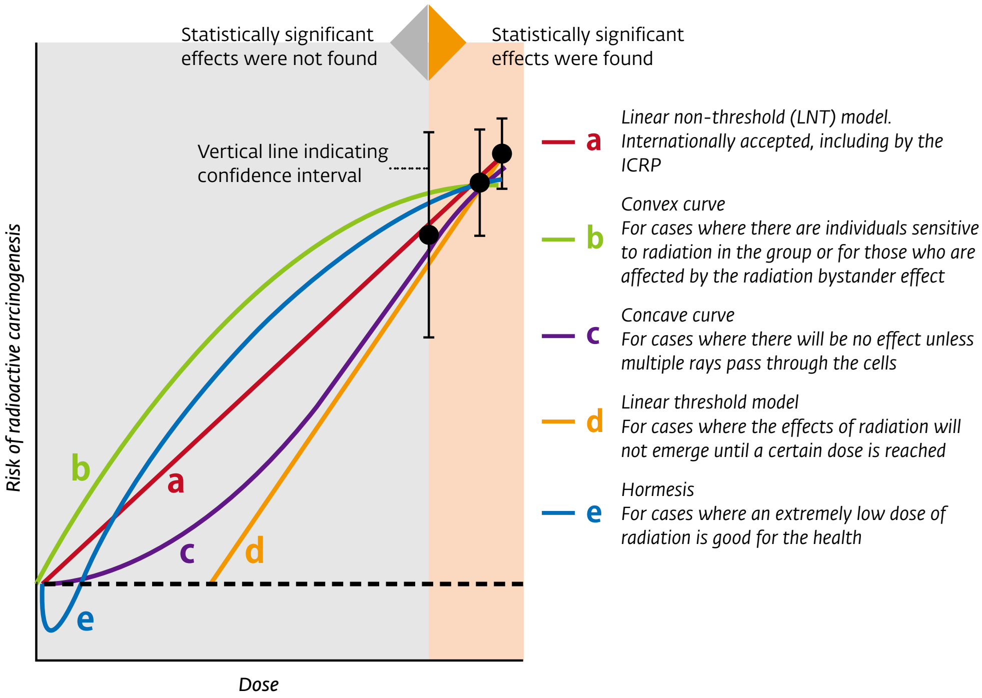
[153] National Research Council, *Health risks from exposure to low levels of ionizing radiation: BEIR VII Phase 2* (The National Academies Press, 2006).

[154] Ozasa K, et al. "Studies of the Mortality of Atomic Bomb Survivors, Report 14, 1950–2003: An Overview of Cancer and Non-cancer Diseases," *Radiation Research*, Vol.177, 2012, 229-243.

[155] Brenner DJ, et al. "Cancer risks attributable to low doses of ionizing radiation: Assessing what we really know," *Proceedings of the National Academy of Sciences*, Vol.100, 2003, 13761-13766.

Figure 4.4.1-1: Carcinogenic risk assessment models [156]

Relationship between low dose exposure and carcinogenesis: five models for the effects of low dose exposure



to carcinogenesis.

The lower the radiation exposure is, the less the risk, but there is zero-risk only when there is zero radiation. This way of thinking is widely recognized by international organizations concerned with radiation's impact on health.

The LNT model is internationally accepted because, in addition to the epidemiological studies of the atomic bomb survivors and others, it also considers the results obtained from a vast number of animal experiments, in vitro experiments, and so on.

With regard to an exposure of 100 mSv or more, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) and NSC both recognize that cancer mortality increases in correlation with dose. A 100 mSv exposure increases cancer mortality by 0.5 percent, according to calculations with the LNT model by the ICRP. This means that if 1,000 people are exposed to 100 mSv, the number of cancer deaths will increase by five. The proportion of cancer deaths among the Japanese is approximately 30 percent, so it follows that 300 out of 1,000 people die of cancer. If 1,000 people are exposed to a dose of 100 mSv, the number of people dying of cancer will increase to 305.[157] Since estimates of the risk of death from cancer for doses of 100 mSv or less are also proportional to dose, as we stated above, it can be calculated that 20 mSv means an increase of one person per 1,000, increasing the number of cancer deaths from 300 to 301. Incidentally, for carcinogenic chemicals that have no thresholds, a carcinogenic rate of one in 100,000 is deemed to be a virtually safe dose.

It is necessary in protecting the public health to assume that there is risk even at levels less than 100 mSv. In this section we have provided values calculated with the ICRP model. There are those, however, who believe that this model underestimates the risk.

3. *Does the risk differ according to the type of exposure?*

[156] Compiled from Brenner DJ, et al. "Cancer risks attributable to low doses of ionizing radiation: Assessing what we really know," *Proceedings of the National Academy of Sciences*, Vol.100, 2003, 13761-13766.

[157] Japan Radioisotope Association, *Kokusai Hoshasen Bogo Iinkai no 1990 Nen Kankoku* (1990 Recommendations of the International Commission on Radiological Protection) (Maruzen, 1991) [in Japanese].

[158] Japan Radioisotope Association, *Kokusai Hoshasen Bogo iinkai no 1990 Nen Kankoku* (1990 Recommendations of the International Commission on Radiological Protection) (Maruzen, 1991) [in Japanese].

The environmental exposure from contamination from this accident at the Fukushima Daiichi plant is a low dose rate radiation exposure over an extended period of time. This is different from a high dose rate radiation exposure, such as in the case of the atomic bomb survivors, who were exposed to a single high dose rate. Is the risk different for the same amount of radiation if it is received all at once or over an extended period of time? There are many sides to this debate. ICRP deems that the risk is lower when the exposure occurs slowly and postulates the risk at half that of the atomic bomb survivors, who were exposed to the same dose all at once.[158] However, there are dissenting views, and some think that there is no difference attributable to variations in the process of exposure. [159]

With regard to the exposure risk for residents due to environmental contamination similar to the accident, there is a study of 29,873 residents of the Techa River basin in Russia. Unknown to local residents, nuclear waste was dumped into the Techa River from the Mayak Production Complex southeast of the Ural Mountains for seven years, beginning in 1949. The average exposure dose was 40 mSv, 55 percent of which consisted of internal exposure. It was reported that mortality per Sv due to solid cancers approximately doubled and leukemia increased by 5.2 times, in comparison with the local control group. [160]

The International Agency for Research on Cancer (IARC) conducted a survey on the risk of death from cancer for over 400,000 nuclear facilities workers in 15 countries. According to the survey results, over 90 percent of the workers were exposed to 50 mSv or less. Cancer deaths increased with an increase in the dose. For all solid cancers excluding leukemia, mortality per Sv was 1.97 times higher when compared to the control group, while leukemia, excluding chronic lymphocytic leukemia, was approximately three times higher than in the control group. [161]

There was also a report that leukemia increased among children five years old or younger living within 5km of nuclear power plants in Germany, the United Kingdom, and Switzerland. In the case of Germany, the dose rate in the vicinity of nuclear power plants is 0.09 mSv per year.[162] So, according to the data, it cannot be said that the risk is lower if the radiation is absorbed slowly. On the other hand, the state of Kerala in India is considered a high background radiation area because of monazite containing thorium in the ground, but an epidemiological survey of the residents did not show a higher cancer incidence.[163] The results, however, are not statistically significant since the number of cancers observed was too low. There is also the possibility that people sensitive to radiation were selectively weeded out over many generations because the residents had been living in the high background radiation area for a long time. There are many things that are unknown about the effects of low dose radiation, and experts' opinions are divided. Further study is required.

4. *Radiation sensitivity differences according to age and individuals*

[159] European Committee on Radiation Risk, "2010 Recommendations of the ECRR, The Health Effects of Exposure to Low Doses of Ionizing Radiation," 2010.

[160] Krestinina LY, et al. "Solid cancer incidence and low-dose-rate radiation exposures in the Techa river cohort: 1956-2002," *International Journal of Epidemiology*, Vol.36, 2007, 1038-1046.

[161] Cardis E, et al. "The 15-country collaborative study of cancer risk among radiation workers in the nuclear industry: Estimates of radiation-related cancer risks," *Radiation Research*, Vol.167, 2007, 396-416.

[162] Koerblein A. "CANUPIS study strengthens evidence of increased leukaemia rates near nuclear power plants," *International Journal of Epidemiology*, Vol. 41, 2012, 318-319; Schmitz-Feuerhake I, et al. "Leukemia in the proximity of a German boiling-water nuclear reactor: evidence of population exposure by chromosome studies and environmental radioactivity," *Environmental Health Perspectives*, Vol.105, Supplement 6, 1997, 1499-1504.

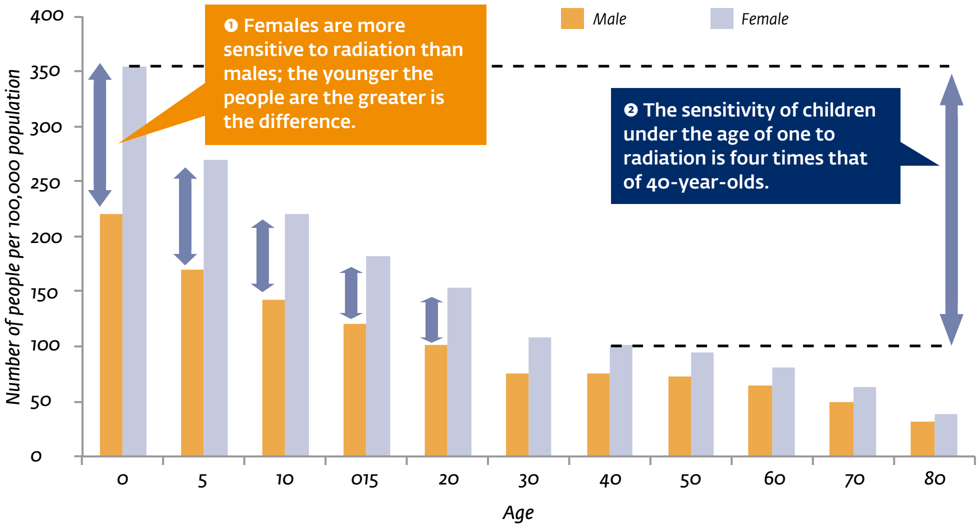
[163] Nair RR, et al. "Background radiation and cancer incidence in Kerala, India-Karanagappally cohort study," *Health Physics,* Vol.96, 2009, 55-66.

[164] The International Physicians for the Prevention of Nuclear War (IPPNW) sent a letter to MEXT Minister Takagi stating that 20 mSv was "dangerous and should be repealed" (April 29, 2011). IPPNW later also sent written recommendations to Prime Minister Kan (August 22). In the United States, Physicians for Social Responsibility held a press conference in which it expressed its criticism of the 20 mSv benchmark (April 26, 2011). However, the Nuclear Disaster Experts' Group, which had been giving advice after the accident mostly to Chief Cabinet Secretary Edano and other members of the Prime Minister's Office on the effect of radiation on the human body and protection, declared that "there will be no effects from radiation since the current exposure dose rate of the residents in the vicinity in Fukushima is 20 mSv or less."

[165] Preston DL, et al. "Studies of mortality of atomic bomb survivors. Report 13: Solid cancer and non-cancer disease mortality: 1950-1997," *Radiation Research*, Vol.160, 2003, 381-407.

The 20 mSv per year benchmark that MEXT set forth as the standard for reopening schools in Fukushima worried parents, and was the subject of much international criticism.[164] Surveys of the Hiroshima and Nagasaki atomic bomb survivors have demonstrated that sensitivity to radiation is higher at lower ages.[165] It has been calculated that the risk for cancer for children under the age of one at the time of exposure is approximately four times higher than the risk for 40-year-old females and three times higher than for 40-year-old males (see Figure 4.4.1-2). Another report states that exposure to an embryo of 10 to 20 mSv increases the risk of infantile leukemia and infantile solid cancers by 1.4 times.[166] Beyond the fact of the higher sensitivity of the young to radiation,

Figure 4.4.1-2: The different impact of radiation according to age and gender (incidence of cancer) [167]



special consideration must be taken of the fact that they have much longer lives ahead of them. It is possible that they will again face the risk of exposure, and the exposure will have a cumulative effect. Twenty mSv per year is the limit for the five-year average exposure dose for adults working at nuclear power plants (100 mSv for 5 years). If we consider the sensitivity of the young, including embryos, the young people in Fukushima will be assuming risks that are even higher than those for radiation workers. Any group will contain a certain percentage of people who are highly sensitive to radiation, so consideration for these radiation-challenged individuals is necessary as a matter of policy.

5. *Diseases due to radiation other than cancer*

Most of the discussions on radiation damage up to now have been concerned with cancer caused by DNA damage. However, cancer is not the only danger to health that we must continue to keep watch over. The life-span study of the Hiroshima-Nagasaki atomic bomb survivors revealed that the mortality rate for diseases other than cancer also increased in parallel with the radiation dose.[168] There was an increase in heart disease as well as cardiovascular, pulmonary, gastrointestinal, and urinary diseases in parallel with the dose.

[166] Wakeford R, et al. "Risk coefficient for childhood cancer after intrauterine irradiation: a review," *International Journal of Radiation Biology*, Vol.79, 2003, 293-309.

[167] Compiled by National Research Council, *Health risks from exposure to low levels of ionizing radiation: BEIR VII Phase 2* (The National Academies Press, 2006).

[168] Shimizu Y, et al. "Radiation exposure and circulatory disease risk: Hiroshima and Nagasaki atomic bomb survivor data, 1950-2003," *British Medical Journal*, Vol.340, 2010, 5349.

[169] Volodymyr Kholosha, Head of the State Agency of Ukraine for Exclusion Zone Management, Ministry of Emergency Situations, at the 7th NAIIC Commission meeting; Yablokov V, et al. "Chernobyl: Consequences of the Catastrophe for People and the Environment," *Annals of the New York Academy of Sciences*, Vol.1181, 2009.

[170] Cabinet Secretariat, "Genshiryoku Saigai Senmonka Gurupu kara no Komento (Comments from the Nuclear Disaster Experts' Group)," third session "Cherunobuiri Jiko to no Hikaku (Comparisons with the Chernobyl Accident)," April 15, 2011 [in Japanese].

[171] MEXT, "Hoshasen wo Tadashiku Rikai suru tame ni: Kyoikugenba no Minasama e (To Properly Understand Nuclear Radiation: for teachers)," April 20, 2011 [in Japanese].

Twenty-six years after the Chernobyl nuclear accident, there was a flurry of reports with information on the state of the residents health in the areas contaminated by radioactive material, that had not been made available until recently.[169] The reports from Ukraine show that there was a conspicuous drop in the immunocompetence of the evacuees from the contaminated areas, as well as that of the clean-up workers, their children, and children that continued to live in the contaminated areas. It was found that the proportion of endocrine system ailments for all of them was high. According to the official views of the Prime Minister's Office[170] and MEXT, [171] infantile thyroid cancer was the only ailment that showed an increase due to the Chernobyl nuclear accident. However, it is clear that even the disease rate of thyroid cancer for adults who were 40 or older at the time of the accident increased. [172]

The effect on health, particularly the health of children, from living for extended periods of time in areas contaminated by radioactive material is a matter of great concern to future Japan. The results of the surveys that the Commission conducted in Ukraine,[173] Belarus, [174] and Russia,[175] as well as the testimony of witnesses to the Commission should be useful in considering the future situation. The one common policy that the three countries continue to follow is protecting the health of the children by sending them to sanatoriums in uncontaminated areas for about three weeks each year so they can eat uncontaminated food. Their illnesses are treated, and general efforts to enhance their physical strength and immunocompetence are made. Also, the Chernobyl Act has been adopted by the three counties, giving the residents living in contaminated areas with an annual dose of 1-5 mSv the right to resettle if they so desire.[176] With this in mind, it is clear how high the Fukushima standard of twenty mSv per year is, especially for highly sensitive children.

6. *How did the government and electric power companies communicate the risk from radiation?*

a. How the risk was communicated

At the Commission's town meetings, we asked the question, "What was the first thing that came to mind after the earthquake?" Concern about the safety of the nuclear power plants was not a common response among the residents who lived in the vicinity of nuclear power plants. We believe this was because, time and time again, they had been told by the power companies and the local government that an accident could never occur.

Residents had been told from the time of their visit as children to the local TEPCO display center that "the nuclear power plants are safe even when an earthquake hits, because they are built on hard bedrock," and that "they are safe because they are protected with five walls of protection." When it came to radiation, which is always produced from nuclear power reactors, they were only told about its safety and benefits: "radiation is safe because it has existed since the beginning of time and human beings have been living within it," and "radiation is useful and is utilized in medical care, manufacturing, and elsewhere." They were never told about the risks associated with the utilization of radiation.

Society at large became aware of this deception when the accident destroyed four supposedly safe nuclear power plants, significantly damaging the trust in the government and the power companies. The reality of how NSC, NISA, and MEXT hid the dangers of nuclear power plants and neglected safety measures became clear through the testimony of witnesses before the Commission (see 4.3.1).

b. Communicating risk from radiation during the accident

[172] IPPNW & GFS. "Health Effects of Chernobyl: 25 years after the reactor catastrophe," *IPPNW and GFS Report*, 2011.

[173] Leonid Tabachnyi, Vice-Chairman, Geophysical Observation Center of Hydrometeorology Department, Ministry of Emergency Situations of Ukraine, at the 7th NAIIC Commission meeting; hearing with Ukraine experts

[174] Hearing with Belarus experts

[175] Hearing with Chernobyl legal experts

[176] Hearing with Chernobyl legal experts

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 (see 4.4.4).

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.

7. *Communicating to the children, who hold the future in their hands*

There are countries where radiation and its effects on health, the mechanism of nuclear power plants, and the lessons learned from past nuclear power plant accidents are taught in detail. France and the United Kingdom, where nuclear power is promoted, aim at giving students a broad understanding of the risks and benefits of nuclear power during their formal education, so that they themselves can make informed decisions.

In France and the United Kingdom, nuclear power and radiation is studied in science and engineering departments not just from a technical point of view but also as a social issue. They want people to think, not only from a basis of scientific knowledge, but from an understanding of the social aspects. [177]

In the United Kingdom in particular, the issues of nuclear power and nuclear energy have been addressed in physics, science and other scientific and engineering text-

[177] The following is a study that introduces undertakings in the United Kingdom and the United States, and undertakings in Japan: Tanaka, Hisanori. "Improving Scientific Literacy – From the Viewpoint of Social Consensus on Public Policy," in *Refarensu* (Reference), Vol.662, March 2006 [in Japanese].

[178] This view of education as a form of "enlightenment" is called the defect model. The defect model "sees the average citizen who is the subject of traditional scientific and technological communication as being in 'a situation lacking accurate scientific knowledge' and considers the injection of knowledge into that person as the purpose of the communication." The idea is that with knowledge, anxiety will dissipate and understanding will grow for its use. Kobayashi, Tadashi, *Toransu Saiensu no Jidai* (The Age of Trans-science) (NTT Publishing Co,2007) [in Japanese]. This book gives a detailed account of the situation in the United Kingdom during this period. An examination of the problems in the Fukushima nuclear power accident and the MEXT response from the perspective of the United Kingdom experience is the following. Ryu, Jumpei. "Chugakko Rika de no 'Genshiryoku' no Atsukaikata ni tsuite no Kosatsu (On the Treatise of Nuclear Power in Secondary Science Education in Japan)," in *Daigaku no Butsuri Kyoiku* (Physics Education in University), Vol.18, No.1, (2012) [in Japanese].

books since 2000. These books include social and actual issues because they feel it is necessary to communicate the risk to the public. The Bovine Spongiform Encephalopathy (BSE) incident in 1995 brought about educational reform due to the loss in faith of the information communicated by the education system and public institutions. This led to an overall reassessment of the problems in the incumbent "Enlightenment" approach to education,[178] and led to an education system that introduced a large element of bidirectional communication that is nurturing scientific and technological literacy.

Both France and the United Kingdom, two of the main countries promoting nuclear power, have education programs based on bidirectional communication between science and policy decision-making. They are mindful of the social impact and aim at building a desirable society based on scientific and technological literacy.

In Japan, a major accident occurred more than one year ago, yet no one has any idea as to when the situation will be under control. The attitude and policy of the government and the power companies remains unchanged. The situation is the same as it was before the accident. The government lacks any sense of urgency. On the other hand, some residents are becoming more proactive, seeking information and studying on their own. They are learning to think critically, based on both objective and scientific grounds, and are also learning to always ask questions. It is important for the next generation of children to inherit these important skills of investigation and discernment.

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,[179] 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. [180]

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.

1. *Iodine tablets and childhood thyroid cancer*

One of the most serious problems that occurred in the Chernobyl nuclear power plant accident in 1986 was that the number of cases of childhood thyroid cancer, which is caused by the thyroid being internally exposed to radioactive iodine, rapidly increased

[179] Special Committee on Nuclear Disaster of NSC, "Genshiryoku Saigaiji ni okeru Antei Yosozai Yobo Fukuyo no Kangaekata ni tsuite (Guideline on Taking Stable Iodine Tablets in Nuclear Emergency)," April 2002 [in Japanese].

[180] Fukushima Prefecture Disaster Prevention Conference, "Fukushima-ken Chiiki Bosai Keikaku Genshiryoku Saigai Taisaku-hen (Fukushima Prefecture Regional Disaster Prevention Plan: Nuclear Emergency Response Section)," revised in FY2009, 67 [in Japanese].

[181] See Reference Material [in Japanese] 4.4.2-1.

in the neighboring three countries. On the other hand, the number of reported cases of the development of childhood thyroid cancer has been zero in Poland, which instructed its people to take iodine tablets as a preventive treatment when the accident occurred. [181]

Radioactive iodine is absorbed into the blood from the airways and lungs as people breathe, or through digestive organs as they eat or drink liquids. Once in the blood, iodine begins to accumulate in the thyroid gland within 24 hours after its incorporation in the human body. The storage of radioactive iodine in the thyroid gland is controllable as long as the level of concentration of stable iodine in the blood is kept high by taking iodine tablets.

The timing of taking iodine tablets is crucial. If iodine tablets are taken 24 hours prior to the incorporation of radioactive iodine in the human body or immediately after radioactive iodine is incorporated, the incorporation of radioactive iodine into the thyroid gland can be inhibited by 90 percent or more. The inhibition rate, however, drops to 10 percent or less if iodine tables are taken 24 hours after the incorporation of radioactive iodine. Iodine tablets are not effective in mitigating the impact of other radioactive substances.[182]

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.[183] 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,[184] 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. [185]

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

[182] NSC's Task Force for Prevention of Disasters at Nuclear Power Facilities, "Genshiryoku Saigaiji ni okeru Antei Yosozai Yobo Fukuyo no Kangaekata ni tsuite (The Guidelines for the Taking of Stable Iodine Tablets as a Preventive Treatment in Times of Nuclear Emergency)," April 2002, 5 [in Japanese].

[183] NISA documents

[184] Hearing with NSC Secretariat

[185] Hearing with NSC Secretariat; NSC Secretariat documents

[186] NSC Secretariat documents

[187] Hearing with NISA's personnel dispatched to the Off-Site Center

[188] Hearing with NSC Secretariat

the NSC Secretariat, who was there working handed this document to a member of ERC,[186] 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. [187]

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. [188]

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."[189] 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.[190] Again, NSC's advice did not lead to the taking of iodine tablets.

In a hearing, a member of NSC said,[191] "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,[192] 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[193] 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 decision-making." 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,[194] 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.[195] 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.

[189] NISA documents; hearing with members of NSC

[190] Hearing with physicians who, upon the central government's request, were dispatched to the local site to give emergency medical care for radiation exposure

[191] Hearing with NSC's members

[192] Hearing with NISA

[193] Hearing with NSC's members

[194] Emergency Technical Advisory Body of NSC, "Hinanchiiki 'Hankei 20km Inai' no Zanryusha no Hinanji ni okeru Antei Yousozai no Touyo ni tsuite (Direction of Administration of the Stable Iodine to the Inhabitant Left Behind during Evacuation from the Evacuation Area '20km radius')," March 16, 2011 [in Japanese].

[195] According to a hearing with the Fukushima prefectural government, a massive amount of papers came in by fax at that time and different people said different things about to whom the document in question should be handed.

[196] Fukushima Prefecture Disaster Prevention Conference, "Fukushima-ken Chiiki Bosai Keikaku Genshiryoku Saigai Taisaku-hen (Fukushima Prefecture Regional Disaster Prevention Plan: Nuclear Emergency Response Section)," revised in FY2009, 67 [in Japanese]. It states, "The Prefecture (i.e. the Regional Nuclear Emergency Response Team) shall distribute stable iodine tablets to its people, among others, and instruct them to take those tablets for the purpose of radiological protection in the event that instructions are given by the NERHQ, etc. about when to take stable iodine tablets as a preventive treatment or based on the Governor's judgment."

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.[196] 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. [197] 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,[198] "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.

c. Cities, towns, and villages that gave instructions to take iodine tablets

As described above, the instructions to start taking iodine tablets once screening reached a figure of 10,000 cpm or above did not reach those to whom they were addressed, namely, the governor of Fukushima Prefecture and the towns in which the nuclear power plants are located. There were two types of actions that the local governments that had a stock of iodine tablets took in response to the absence of the Instructions from the central government and the governor of the prefecture. Four towns, i.e. Futaba Town, Tomioka Town, Okuma Town, and Miharu Town, made independent judgments to distribute and instruct their residents to take the tablets. hearings with Futaba Town, Tomioka Town, and Miharu Town[199] revealed that the three towns had the same awareness in making the decision: "Although no instructions were coming from the prefectural government, we decided that our people should start taking iodine tablets just in case of a serious radiation impact."

Miharu Town was aware of the potentially adverse side effects of iodine tablets, having obtained the information from physicians and the internet. Yet, the town decided in an evening meeting on March 14 that everyone should take iodine tablets. The decision was made based on the information that prevailing winds from the nuclear power plant would bring the radioactive plume to the town on March 15. A Miharu Town official said, "We were concerned about the side effects. At the same time, though, we took into account the possibility of incurring increasingly serious radioactive damage. We

[197] NISA documents

[198] Yuhei Sato, Governor of Fukushima Prefecture, at the 17th NAIIC Commission meeting

[199] Hearing with each of related cities, towns, and villages

[200] In a hearing, an Okuma Town official said, "The number of people confirmed to have received iodine tablets on March 15 is 339, but we also distributed the tablets to non-residents of Okuma Town who were also there in evacuation centers. I received the report on Miharu Town's decision to instruct its people to take iodine tablets from a staff member of our town after we distributed our tablets."

took the safer side and decided that we should take iodine tablets."

Okuma Town made a local decision and requested that the people evacuated from Okuma Town to Miharu Town, who numbered approximately 340, take iodine tablets.[200] The four towns that gave instructions to take iodine tablets could not deploy physicians to oversee the taking of iodine tablets to all evacuation centers, and therefore had public health nurses and pharmacists crush the tablets to adjust the amount of stable iodine to be administered to children.

d. Iwaki City and Naraha Town that implemented distribution only

Iwaki City and Naraha Town (Iwaki City was the destination to which Naraha Town evacuated) only distributed the iodine tablets. In Iwaki City, the distribution of iodine tablets started on the morning of March 16, after the city mayor gave the order. They were distributed in places such as the City Hall, its branch offices, and evacuation centers. Naraha Town, which was evacuating to Iwaki City, started the distribution of iodine tablets one day earlier, on March 15, upon learning that Iwaki City was going to commence distribution.

With regard to the judgment on whether the iodine tablets should be taken or not, an Iwaki City official said, "Local governments had no information about a spatial dose rate levels of radiation, nor did we have information about the status of the nuclear reactors. We did not know when to take the iodine tablets. In that situation, it was difficult to make a decision about whether to request that our people take iodine tablets." A Naraha Town official recalled how the town made a judgment on when to take

Figure 4.4.2-1: Situation of distribution of iodine tablets and instructions to take iodine tablets by each city and town

Although they were not aware of the spatial dose rate levels of radiation and were uncertain about when to take iodine tablets, some cities and towns distributed iodine tablets and instructed their people to take those tablets for the purpose of radiological protection, in the absence of physicians in evacuation centers.

	Cities and towns	Time and date of distribution and instructions	Number of people to whom iodine tablets were distributed	Presence of medical experts	Reason why instructions to take iodine tablets were and were not given
Gave instructions to take iodine tablets	*Tomioka Town*	*Evening of the March 12 and 13*	*The number of people: Unknown The number of tablets distrbnted=21,000*	*Under public health nurses' instructions*	*The town officials judged that it would be better for people to take iodine tablets just in case.*
	Futaba Town	*March 13*	*Iodine tablets were for its people evacuated to Kawamata Town. At least 845 people took iodine tablets.*	*Pharmacists*	*The town officials judged, in response to the occurrence of the hydrogen explosion, that it needed to take protective measures.*
	Okuma Town	*March 15*	*340 people who evacuated to Miharu Town*	*Unknown*	*Town officials, who were in Miharu Town, made the decision which was subsequently reported to the town mayor.*
	Miharu Town	*13:00 to 18:00 of March 15*	*7,250 people*	*Under public health nurses' instructions*	*Taking into account the direction in which wind would flow, the town judged that radiation would reach Miharu Town.*
Distributed iodine tablets to individuals	*Iwaki City*	*From Morning of March 16*	*The number of people: 152,500 The number of tablets distributed: 257,700*	*Pharmacists*	***They had no information about the spatial dose rate level of radiation nor did they have information about the status of the nuclear reactors. They did not know when to take iodine tablets. The situation being as such, they were waiting for instructions from the prefectural government.***
	Naraha Town	*Afternoon of March 15*	*3,000 people who evacuated to Iwaki City*	*Pharmacists*	
Distributed iodine tablets to evacuation centers	*Namie Town*	*March 13 and 14*	*8,000 people who evacuated to the town's Tsushima district*	*Unknown*	

iodine tablets, saying, "It was specified that iodine tablets should be taken only once, but judgment on when to take iodine tablets was difficult because the likelihood of the nuclear power plant exploding again was unpredictable and because we did not know to what extent radioactive materials were spreading."

Both Iwaki City and Naraha Town had implemented the distribution of iodine tablets to their people, but they lacked the information necessary to make a decision on when to take those tablets and, therefore, had no choice but to wait for instructions from the central or prefectural government.

e. Cities, towns, and villages located within a range of 30km that neither implemented distribution nor gave instructions to take iodine tablets

Namie Town was the only town among the cities, towns, and villages located within a 10km radius of the Fukushima Daiichi Nuclear Power Plant that neither distributed iodine tablets to its people nor instructed them to take iodine tablets. The Town Emergency Response Headquarters of Namie Town, together with many people in the town, evacuated on the March 12 to the town's Tsushima district. At that time, Namie Town officials distributed the iodine tablets to evacuation centers but postponed their distribution to the people due to the absence of the Instructions from the central or prefectural government. A Namie Town official said, "We did not know the spatial dose rate level of radiation nor did we have communication tools. Therefore, we as the town could not instruct our people to take iodine tablets. We could not decide who would take responsibility should the side effects cause death or if our people panicked." They were unable to make decisions because they had no information necessary for decision-making.

Minamisoma City, which is located within a 20-30km radius of the nuclear power plant, decided on March 12 in a meeting of the City Emergency Response Headquarters that it should distribute iodine tablets to the people living in Odaka Ward, and they started making preparations accordingly. They failed to distribute iodine tablets in time, however, because many of its citizens had already started voluntary evacuation in response to the expansion of the evacuation zone and also to the explosion of Unit 3.

The lack of information about the spatial dose rate level of radiation and the status of nuclear reactors, in addition to the absence of the Instructions from the central or prefectural government, made it difficult for many cities, towns, and villages to make a judgment concerning the taking of iodine tablets. [201]

3. *Regarding the presence of medical experts during iodine taking and the problems to be remedied*

The Safety Commission's advisory documents concerning the taking of iodine tablets state "Please take iodine tablets only when physician's instructions are available" (March 14) and "Please use iodine tablets in the presence of medical experts" (March 15 and 16). Their presence is recommended "in order to give treatment to patients suffering from the side effects of iodine."[202] Indeed, the NSC has expressed its opinion in the Guidelines for the Taking of Iodine Tablets, that it is desirable if medical experts can be dispatched to treat the potential development of side effects, etc. to places in which residents and others are assembled for the purpose of evacuation. According to the Ministry of Health, Labour and Welfare (MHLW),[203] however, as far as the distribution of iodine tablets in emergency situations is concerned, the presence of physicians

[201] We asked the local governments situated within a radius of 30km why they did not use iodine tablets. Some of the answers:
- "We evacuated early enough, so we were not concerned about that." (Katsurao Village)
- "Iodine tablets arrived at the village hall in the evening of March 16. By that time, everyone in our village had already been evacuated. There was no explanation or instruction given, so we did not use them." (Kawauchi Village)
- "We had no information and we were too busy making evacuation arrangements to pay our attention to iodine tablets." (Hirono Town)
- "We were waiting for instructions from the prefectural government." (Tamura City)

[202] Hearing with NSC Secretariat

[203] Hearing with MHLW

[204] See Reference Material [in Japanese] 4.4.2-1.

is desired but not required.

The probability of side effects from iodine tablets is, in the first place, considered low. People with a hypersensitivity to iodine, may develop hives or exhibit other allergic reactions, though the probability is low. In the case in Poland in which iodine tablets were administered to 10.5 million people, no serious side effects were reported among the youngsters.[204] As for the Fukushima Daiichi plant accident, it is reported that there were complaints from some people in Miharu Town who had taken the iodine tablets, such as: "I feel nauseous," "I am allergic to iodine but I accidently took the pill," and "I feel sick," but it is also reported that these were all mild symptoms. There has been no report from other cities, towns, and villages that gave residents iodine tablets of people suffering from any serious side effects.

In addition, even if someone who took iodine tablets developed a serious side effect, the damage incurred is to be compensated for under an aid system for side effect damage incurred by taking pharmaceutical products, as long as iodine tablets are used properly for proper purposes (e.g. the damage in question is not incurred due to excessive administration).[205] The presence of medical experts becomes necessary when a nuclear accident has occurred. For a child aged three or younger to take an iodine tablet, syrup must be made using a powdered iodine tablet, which is designated as "drastic medicine" by the Pharmaceutical Affairs Act, or the dose must be adjusted properly by crushing the pill. It is desirable if medical experts, pharmacists in particular, are present at evacuation centers for the purposes of distributing iodine tablets and giving instructions to the people who take those tablets.

4. *Assigning responsibility, and creating effective response measures*

According to the provisions of the prefecture's regional disaster prevention plan, the prefectural government has the primary authority for the distribution of iodine tablets to the people in the prefecture. That authority shall be exercised based on the instructions from the NERHQ or on the governor of the prefecture's judgment. The fact that the governor did not exercise this authority is one reason why iodine tablets were not distributed and taken in many cities, towns, and villages.

ERC received NSC's advice on March 13, which advised that iodine tablets should be taken, but it did not give these instructions to distribute and take iodine tablets in accordance with the NSC's advice to the Fukushima prefectural government. Meanwhile, the Fukushima prefectural government kept waiting for the instructions from the central government.

The governor of Fukushima Prefecture could have made the decision independently, but did not exercise that authority and instead kept waiting for the central government's instructions. As a result, many cities, towns, villages, failed to give instructions to their people to take iodine tablets, despite having stock, because they, too, were waiting for the instructions from the NERHQ or the governor of the prefecture.

In the responses taken by each city, town, and village upon the occurrence of the accident, steps were not taken to reduce the initial exposure impact on their respective people by giving them iodine tablets because there were no instructions. Who were responsible for that? Both the ERC and NSC, which failed to communicate adequately with each other in a time of emergency; as well as the governor of the prefecture, who had the information necessary to make a decision to commence the administration of iodine tablets but did not give the go ahead.

Should a nuclear disaster equivalent to this accident or larger happen in the future, what measures would be needed for the people affected to be duly instructed to take iodine tablets in a timely manner, depending on the spatial dose rate level of radiation and the status of the nuclear reactors? Criteria for the commencement of the taking of iodine tablets at an operational intervention level must be established. Response measures to be taken by cities, towns, and villages must also be settled so that instructions regarding iodine tablets can promptly be given to the people affected. It is particularly

[205] Act on Pharmaceuticals and Medical Device Agency (Act No. 192 of 2002); Hearing with MHLW

important that a system be established to ensure that children, who are thought to have a higher risk of thyroid cancer, can be properly treated with the tablets.

4.4.3 Internal exposure countermeasures and health management in the future

There are two kinds of internal exposure: that caused by the inhalation of air containing radioactive materials, and that caused by the oral ingestion of food contaminated with radioactive materials.

In the Fukushima Daiichi plant accident, radioactive iodine was emitted. Radioactive iodine can cause thyroid cancer through internal exposure if it is ingested into the human body. In the initial period immediately after the accident occurred, the risk that residents would be exposed internally due to inhalation of radioactive iodine (the risk of initial exposure) was high, so it was important to start investigating this possibility. However, the Nuclear Emergency Response Headquarters (NERHQ) did not conduct a sufficient investigation.

Radioactive iodine was not the only radioactive material emitted in the accident. Radioactive cesium with a significantly longer half-life than radioactive iodine[206] was emitted into the atmosphere and into the sea, as well as being deposited in soil and lakes, etc. This radioactive cesium was transferred from the environment into food. The problem in the medium to long term is that residents face the risk of exposure due to oral ingestion of food contaminated by radioactive materials (the risk of medium- to long-term internal exposure).

After the Chernobyl nuclear accident, the government of the former Soviet Union responded by determining emergency regulation values for contaminated food, and over time, gradually strengthened its regulations. That policy was inherited by Russia, Belarus, and Ukraine after the collapse of the Soviet Union, and the food covered by the regulations was also categorized more precisely as time passed; still today they are continuing to manage the radioactive contamination of food. Furthermore, these three countries have been monitoring the internal exposure levels of residents, and, with the results of these investigations, they have been continuing to work hard to reduce the internal exposure of residents by adopting, for example, recuperation policies, etc. at facilities for health promotion (commonly known as sanatoriums).[207] In Japan as well, the national government and the local governments should not only use regulations to manage the contamination of food by radioactive materials, they should also regularly monitor the internal exposure levels of the residents; after taking into account the results of these investigations, they should formulate meticulous countermeasures matched to the life of each individual resident.

In this section, we will discuss the importance of the evaluation of initial exposure. Then, from the perspective of reducing medium- to long-term internal exposure to radioactive cesium, we will examine the establishment of the provisional regulation values for food that were stipulated in March 2011 and the system of shipping regulations. Finally, we will indicate the issues in the Prefecture Health Management Survey being implemented in Fukushima Prefecture.

[206] The half-life of cesium 134 is 2.1 years, and the half-life of cesium 137 is 30 years.

[207] For example, in a sanatorium in Belarus each class recuperated for three weeks. Lessons were held, but healthcare professionals were also permanently stationed in the sanatorium. On the first day internal exposures were measured with WBC tests, and preventative programs were implemented as necessary (Hearings with Belarus sanatorium staff).

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 record-keeping, and the investigation into the initial exposure levels of the residents was not handled sufficiently.

The effective half-life[208] of iodine 131 is about five to seven days in infants and children,[209] 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[210] over four months from March 11. (See Reference Material [in Japanese] 4. 4. 3-1.)

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.[211] 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.[212] 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-

[208] "Effective half-life" refers to the period in which the amount of radioactivity halves due to the action of both the physical half-life of the radionuclides ingested into the human body, and the biological half-life that physiologically halves the amount of radiation due to excretion, etc.

[209] ICRP, *Age-dependent Doses to Members of the Public from Intake of Radionuclides - Part 2 Ingestion Dose Coefficients*, ICRP Publication 67, 1992.

[210] Fukushima Prefecture, "Kenmin Kenko Kanri Chosa 'Kihon Chosa' no Jisshi Jokyo ni tsuite (Implementation Status of the Prefecture Health Management Survey's Basic Survey)," at the 6th Meeting of the Fukushima Prefecture "Kenmin Kenko Kanri Chosa (Prefecture Health Management Survey)," Survey Committee, April 26, 2012 [in Japanese].

[211] Based on the emission source information published by NSC on March 23 2011 and retrospectively estimated by SPEEDI, the diagram showing the equivalent thyroid dose for a one year old child estimated assuming the child was outside for 24 hours in the period from March 12 to March 24 indicates the possibility that there are people who were exposed to over 100mSv in thyroid equivalent dose outside the 30 km zone around Fukushima Daiichi Nuclear Plant as well. In response to this, NSC made a request to NERHQ on March 25 to measure the thyroid dose of children in regions assessed as having a high thyroid equivalent dose and in the Indoor Evacuation Zone.

[212] NSC, "Shoni Kojyosen Hibaku Chosa Kekka ni taisuru Hyoka ni tsuite (Regarding The Assessment of the Children's Thyroid Radiation Exposure Test Results)," September 9, 2011 [in Japanese].

[213] NSC Secretariat, "Shigatsu Mikka zuke Hisaisha Shien Chimu Iryohan kara no Genshiryoku Anzen Iinkai eno Shokai ni taisuru Kaito (Answer to the Inquiry to NSC from the Medical Group of the Nuclear Sufferers Life Support Team Dated April 3)," February 21, 2012 [in Japanese].

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."[213] 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.[214]

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.

In the case of the Chernobyl nuclear accident, the government of the former Soviet Union did not take measures to protect the residents by distributing and administering iodine tablets. Moreover, it concealed contamination information from the residents for three years, leading to a further increase in iodine exposure, because tests for contamination of home-made milk and vegetables were not performed.[215] However, the thyroid gland exposure levels of approximately 130,000 children and juveniles in Ukraine[216] and approximately 40,000[217] in Belarus were measured and investigated over a period of almost one month after the occurrence of the accident. Compared to the immediate response in the Chernobyl nuclear accident, the study of initial exposure by the Japanese government was insufficient.

2. *Contamination of food by radioactive materials, and internal exposure countermeasures*

The most important issue for preventing or reducing the internal exposure of the residents in the medium to long term is how to prevent the ingestion of food contaminated with radioactive materials. Therefore, the problem becomes the type of food ingestion restrictions and shipping regulations the regulatory authorities should introduce.

After the accident occurred, in order to prevent the distribution of food contaminated with radioactive materials, the MHLW established the provisional regulation values for radioactive materials in the Food Sanitation Act based on the Indices related to Restrictions on the Ingestion of Food and Drink in the Emergency Preparedness Guide on March 17, 2011.[218] From March 21, 2011 onwards, the Nuclear Emergency Response Headquarters imposed shipping restrictions on food, based on the Nuclear Emergency Preparedness Act, Article 20, Paragraph 3, in case food contaminated in excess of the provisional regulation values was discovered in the tests conducted by the prefectures. The citizens began to distrust the safety of food for a number of rea-

[214] Hearings with the Institute of Radiation Emergency Medicine at Hirosaki University. The team at this institute measured the thyroid internal exposure of a total of 62 people, from infants to elderly people, including people who were staying in the Tsushima district of Namie Town. However, the Fukushima Prefecture Local Medical Care Division asked them to "stop measuring people because it would cause unease." In this investigation, iodine 131 was detected in 46 of the 62 subjects (tested from April 12 to April 16). If calculated as the inhalation of the plume on March 15, there were no people among these residents with a thyroid equivalent dose in excess of 50mSv. However, extrapolating from the maximum value of the measurement suggests the possibility that there were infants with over 50mSv of exposure.

[215] Hearings with Chernobyl nuclear plant accident experts

[216] Ministry of Emergency Situation of Ukraine, *Twenty-five Years after Chernobyl Accident: Safety for the Future,* (KiM, 2011).

[217] Belarus Ministerial Conference, *20 Лет после Чернобыльской катастрофы, Последствия в республике Беларусь и их преодоление* (Belarus 20th Anniversary National Report), (2006) [in Belarusian].

[218] The provisional regulation values are created taking into account the index values stipulated in the disaster prevention guidelines, and the standards (the "Codex" standards) stipulated by the Codex Alimentarius Commission, an intergovernmental institution established by the World Health Organization (WHO) and the Food and Agriculture Organization of the United Nations (FAO). In other words, because iodine has a large effect on the thyroids of infants, after referring to the Codex standards, the standard for radioactive iodine in milk and milk products became an instruction not to use modified milk powder for infants and milk used directly for drinking that is in excess of 100Bq/kg.

sons: at first there was not enough measuring equipment; the number of items and the number of measurements were both limited; some nuclides failed to be included initially in the provisional regulation values; and a number of different foods contaminated in excess of the provisional regulation values, including beef raised using contaminated rice straw, natural wood mushrooms, etc., were discovered. On April 1, 2012 MHLW stipulated new standard values five times stricter than the provisional regulation values, and shipping regulations on food are currently being imposed based on these new values. But it is difficult to conclude that the citizens' feelings of distrust regarding food safety have been sufficiently calmed.

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.[219] 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[220] 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.[221] 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.[222]

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. [223]

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 ship-

[219] Before this accident, no legal regulation values for radioactive substances in domestically produced food had been established, except for the stipulation of provisional limits for radioactive substances for imported food under the Food Sanitation Act (a total of 370Bq/kg radioactive cesium 134 and 137) by MHLW in response to the Chernobyl nuclear plant accident. Before the Fukushima accident, if food contaminated with radioactive substances in excess of the provisional limits was discovered at quarantine stations, etc. the importer was instructed to send it back. MHLW, "Hoshano Zantei Gendo wo koeru Yunyu Shokuhin ni tsuite (Discovery of Imported Food in Excess of the Radiation Provisional Limits 'Report No. 34')," November 8, 2001 [in Japanese], etc.

[220] "Environmental sample monitoring" refers to the monitoring of leafy vegetables, weeds, etc. carried out by Fukushima prefectural government based on the Prefecture Regional Disaster Prevention Plan.

[221] Regarding the above, as of March 16, 2011 the only data published by Fukushima Prefecture is the 177Bq/kg of Iodine 131 and 33Bq/kg of Cesium 137 detected in the water supply at the Fukushima Branch of the Environmental Radioactivity Monitoring Center; the other detections of iodine in this text were not published in March 2011. Local NERHQ and Fukushima Prefecture, "④Fukushima Daiichi Genshiryoku Hatsudennsho Shuhen no Monitaringu Kekka Ichiran 'Kankyo Shiryo' ('iv' List of Monitoring Results in the Vicinity of the Fukushima Daiichi Nuclear Plant 'Environmental Samples')," June 3, 2011 [in Japanese].

[222] Emergency Technical Advisory Body of NSC, "Inshokubutsu no Sesshu Seigen ni tsuite (Food and Drink Intake Restrictions)," March 16, 2011 [in Japanese].

[223] MHLW stipulated "Inshokubutsu no Sesshu Seigen ni kansuru Shihyo (the Indices related to Restrictions on the Ingestion of Food and Drink)" in the Guideline for Nuclear Emergency Preparedness as the provisional regulation values, considered food which exceeds these values to fall under the category of "Articles which contain or are covered with toxic or harmful substances or are suspected to contain or be covered with such substances" in the Food Sanitation Act, Article 6, Item (ii), and issued a notification to the effect that the ministry wanted sufficient measures to be taken with regard to sales and other handling of such items so that they will not be used for food (Notice No. 0317, Article 3 of the Department of Food Safety). The provisional regulation values were stipulated without receiving an evaluation of the impact of food on health because it was an emergency situation. On March 20, 2011, MHLW asked the Food Safety Commission for an optional food impact assessment based on the Food Sanitation Act, Article 24, Paragraph 3. In response to this, the Food Safety Commission issued the "Emergency Report on Radioactive Materials" on March 29, 2011. The commission made an assessment that a thyroid equivalent dose of radioactive iodine of 50mSv per year and radioactive cesium of 5mSv per year would

ping 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. [224]

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.[225] 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[226] 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

be expected to be safe enough to prevent food-borne radioactivity exposure, but this assessment was based on an extraordinary and critical social situation, namely the emission of radioactive substances due to the occurrence of this accident, while the commission also mentioned that this emergency report should not be used as the basis for risk management measures in normal circumstances. The commission held nine further discussions in working groups and on October 27, 2011 notified MHLW of its Risk Assessment Report on Radioactive Nuclides in Food . The report summarized the views of the commission, including their judgment that "within the scope of the assessment of the impact of food on health performed by the Food Safety Commission, the impact due to radioactivity detected was about over 100mSv as the cumulative lifetime effective dose, after excluding the amount of radiation people receive in the course of their normal lives. In that process the commission considered the fact that susceptibility (to thyroid cancer and leukemia) is higher in childhood than in adulthood. It is difficult to verify an impact on health due to less than 100mSv of radiation, based on the findings the commission have currently obtained."

[224] Hearings with MHLW

[225] Seven cases from Fukushima Prefecture (all of them were raw milk), 17 cases from Ibaraki Prefecture (all of them were spinach), seven cases from Tochigi Prefecture (all of them were spinach), one case from Tokyo Metropolis (edible chrysanthemum), and three cases from Gunma Prefecture (spinach in two cases and kakina in one case).

[226] Head type leafy vegetables produced in Fukushima Prefecture and raw milk, parsley, etc. produced in Ibaraki Prefecture.

[227] Subsequently, NERHQ made a revision on June 27, 2011 taking into account the impact of the cesium and the state of food ingestion at that time, added beef and rice on August 4, 2011, and on March 12, 2012 revised its approach to lifting the restrictions taking into account the establishment of the new standard values.

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.[227] 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.

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.[228] 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.[229]

b. Validity and problem areas of the provisional regulation values

The provisional regulation values were stipulated using an effective dose of 5mSv/year of radioactive cesium (50mSv/year in the case of a thyroid gland equivalent dose caused by radioactive iodine) as the standards, in accordance with the “Indices related to Restrictions on the Ingestion of Food and Drink” stipulated in the Emergency Preparedness Guide and the standards of the Codex Alimentarius Commission. The following table shows the provisional regulation values (Table 4.4.3-1).

In the provisional regulation values, referring to the standards of the Codex Alimentarius Commission, there is a cautionary note regarding milk and milk products containing iodine in excess of 100Bq/kg which says, “instruct people not to use them in powdered milk for infants or milk used directly for drinking,” but it appears that no consideration was given to people other than infants with high susceptibility to radiation.

The indices which form the basis for the above regulation values are values determined by: dividing the Japanese people into three categories, adults, children and infants; using the conversion factor of the ICRP with the amount of food ingested per year on average by each category as the standard to calculate the concentration of radioactive materials, which is the limit at which the government intervenes to prevent exposure in excess of 5mSv per year; and stipulating the minimum values as the index values. For this reason, there is a certain degree of consideration given to people with high susceptibility to radiation in the establishment of the provisional regulation values. [230]

Consideration has been given to the radiation susceptibility of individual people to a certain extent, but the index values and the provisional regulation values based upon them are not necessarily values that take into consideration all exposure routes. In the debate when NSC formulated the index values, the index values were stipulated with 5mSv per year as the standard, with no consideration given to the external exposure dose or the internal exposure dose due to inhalation; rather, only internal exposure through food was considered. The possibility of multiple exposure routes was not taken into sufficient consideration, so the index values and the provisional regulation values may not necessarily ensure the health of citizens.

Moreover, the index values are values used as a guide when the regulatory authorities decide to intervene in an emergency situation by introducing measures to restrict the ingestion of food and drink as protective actions, and are not con-

[228] MHLW, “Shokuhinchu no Hoshasei Busshitsu Kensa no Kekka ni tsuite 'Gairyaku' (Test result of radioactive materials in food 'Summary'),” April 3, 2011 [in Japanese].

[229] MHLW, “Shokuhinchu no Hoshasei Busshitsu Kensa no Kekka ni tsuite ‘Heisei Nijyuyo Nen San Gatsu Sanjyuichi Nichi madeno Kensa Jisshibun’ (Sum up of test result of food sampled until 31 March 2012),” Up-to-date Report as April 2,2012, Press Release [in Japanese].

[230] Hearings with NSC Secretariat

[231] Hearings with NSC Secretariat

[232] Japan Radioisotope Association, *Kokusai Hoshasen Bogo Iinkai no 2007 Nen Kankoku* (The 2007 Recommendations of the International Commission on Radiological Protection) (Maruzen, 2009) [in Japanese].

Table 4.4.3-1: Provisional regulation values for food published in March 2011

Product	Radioactive iodine (typical nuclide in nuclide mixture: I-131)
Drinking water	300Bq/kg or more
Milk and milk products*	
Vegetables (excluding root crops and potatoes)	2000Bq/kg or more
Product	**Radioactive cesium**
Drinking water	200Bq/kg or more
Milk and milk products	
Vegetables	500Bq/kg or more
Grains	
Meat, eggs, fish, and other	
Product	**Uranium**
Food for infants	20Bq/kg or more
Drinking water	
Milk and milk products	
Vegetables	100Bq/kg or more
Grains	
Meat, eggs, fish, and other	
Product	**a-nuclides of plutonium and transuranic elements(total concentration of radiation from Pu-238, Pu-239, Pu-240, Pu-242, Am-241, Cm-242, Cm-243, Cm-244)**
Food for infants	1Bq/kg or more
Drinking water	
Milk and milk products	
Vegetables	10Bq/kg or more
Grains	
Meat, eggs, fish, and other	

** Note: The instruction was not to use products in excess of 100Bq/kg for modified milk powder for infants or milk used directly for drinking*

centration standards for judging whether or not radioactive materials in food and drink have negative effects on health in the long term. Originally, it was anticipated that the regulatory authorities would refer to these index values to decide standards by comparing the advantages of minimizing the health effects due to ingestion of radioactive materials and the disadvantages of malnutrition, etc. due to restrictions on ingestion.[231] However, MHLW, the regulatory authority in this case, actually adopted largely unchanged the index values as the provisional regulation values. As stated above, these figures were five times the dose limit of 1mSv/year for public exposure at normal times as stipulated by the ICRP, [232] and were not necessarily standards that gave the top priority to safety.

Furthermore, the Emergency Preparedness Guide scenario anticipated an accident scenario in which that emission of radioactive materials would only continue for 24 hours.[233] Regarding the index values and the shipping restrictions on food based on them that are predicated on such a scenario, the time period is not clearly stated in the Emergency Preparedness Guide, but it is apparent that a prolonged crisis was not anticipated.[234] NSC advised the urgent establishment of new criterial values on June 2, 2011, and gave advice to the same effect several times after that. But it had to wait

[233] NSC, "EPZ ni tsuite no Gijututeki Sokumen kara no Kento (Study on Technical Aspects of the EPZ)," Supplementary Document 4 of the Guideline for Nuclear Emergency Preparedness, revised in August 2010 [in Japanese].

[234] Hearings with NSC Secretariat

until April 1, 2012 for the establishment of the new standard values. This commission concludes that the new standard values were not established for more than one year after the accident because the MHLW went through the same process it takes during normal times when setting the standard values; in other words, it consulted with the Food Safety Commission.

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.[235] 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.[236]

(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.[237] 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

[235] The measures to restrict the shipping of food and drink anticipated in the Prefecture Regional Disaster Prevention Plan were to be carried out by Fukushima prefectural government through the process of giving instructions to the relevant municipalities to restrict shipping, with reference to its monitoring during the emergency, and the relevant municipalities prohibiting the residents, producers and production and distribution-related institutions and organizations from shipping agricultural, livestock and marine products.

[236] Reference Document of Appendix 1 of MHLW. "Nochikusuisanbutsu-to no Hoshasei Busshitsu Kensa ni tsuite (Inspection on Radioactive Materials in Agricultural, Livestock and Marine Products, etc.)," April 4, 2011 [in Japanese].

[237] Hearings with Fukushima prefectural government

[238] Hearings with Fukushima prefectural government

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,[239] 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. [240]

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.[241] 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).[242] 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

[239] Hearings with MAFF

[240] MHLW, "Gyokairui chu no Hoshasei Yoso ni kansuru Zantei Kiseichi no Atsukai ni tsuite (The treatment of provisional regulations for radioactive iodine in seafood)," April 5, 2011 [in Japanese]; Working Group on Radioactive Materials Measures, Pharmaceutical Affairs and Food Sanitation Council of MHLW, "Gyokairui chu no Yoso ni kansuru Tomen no Shoken (Provisional Remarks on Radioactive Iodine in Fishery Products)," April 8, 2011 [in Japanese].

[241] NSC, "Inshokubutsu Sesshu Seigen ni kansuru Shihyo ni tsuite (Indices for food and beverage consumption regulations)," document 20-4, March 6, 1998 [in Japanese].

[242] Fisheries Agency, "Suisanbutsu no Sutoronchiumu Sokutei Kekka ni tsuite (Monitoring Results of Strontium in Fisheries Products)," June 27, 2011 [in Japanese].

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. [243]

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.[244] 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. [245]

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.

f. Detailed food regulations in Belarus, Russia, and Ukraine

Table 4.4.3-2 shows the EU food regulations for Belarus, Russia, and Ukraine, all of which were affected by the Chernobyl nuclear power plant accident. Detailed regulations were placed on food products in the countries surrounding the Chernobyl Nuclear Power Plant in accordance with the food preferences of citizens. In Ukraine

[243] On July 19, NERHQ ordered Fukushima Prefecture to restrict the shipment of cattle feed in the prefecture to other prefectures and to slaughterhouses. Similar shipping restriction orders were subsequently placed on Miyagi Prefecture (July 28), Iwate Prefecture (August 1), and Tochigi Prefecture (August 2). For this reason, the inspection structure was enhanced for cattle. This included the requirement for inspections of all cattle in deliberate evacuation area and areas prepared for emergency evacuation etc., and farm-based inspections (one or more cattle were inspected for initial shipments for each farm) for all other areas in Fukushima Prefecture.

[244] MAFF and Forestry Agency, "Kinoko Genboku oyobi Kinsho Yo Baichi no Tomen no Shihyochi no Settei ni tsuite (Establishment of Provisional Reference Indices on Raw Logs and Growth Substrate to Cultivate Mushrooms)," October 6, 2011 [in Japanese].

[245] Hearings with MAFF

Table 4.4.3-2: Regulations (Bq/kg) on cesium 137 for food products set after the Chernobyl nuclear accident[246] and new standards (Bq/kg) set on cesium in food products in Japan applied from April 2012

Category	EU 1986	Belarus 1999	Russia 2001	Ukraine 1997
Milk	370	100	100	100
Infant products	370	37	40-60	40
Dairy products	600	50-200	100-500	100
Meat/processed meats	600	180-500	160	200
Fish	600	150	130	150
Eggs	600	-	80	6Bq/Egg
Vegetables, fruits, potatoes, and root crops	600	40-100	40-120	40-70
Bread, wheat, and cereal products	600	40	40-60	20

Category	Japan
Drinking water	10Bq/kg
Milk	50Bq/kg
Common foods	100Bq/kg
Infant foods	50Bq/kg

and other locations, a standard of 1 mSv/y was placed on individual agricultural and fishery products after the accident.

In Japan, index values were only set for broad categories. The basic concept of 1 mSv/y is the same for Japan and these countries; however, countries around the Chernobyl nuclear power plant responded to the situation with more detailed criteria than Japan.

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.[247] 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.[248] 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;[249] 3) a survey for pregnant women;[250] and 4) a survey on mental health and living habits. [251][252]

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

[246] IAEA, "Environmental Consequences of the Chernobyl Accident and their Remediation: Twenty Years of Experience, Report of the Chernobyl Forum Expert Group 'Environment'," 2006.

[247] Review Committee for the Fukushima Health Management Survey, "Kenmin Kenko Kanri Chosa no Gaiyo (Outline of the Fukushima Health Management Survey)," June 18, 2011 [in Japanese].

[248] According to Fukushima Prefecture Health Monitoring Survey Committee documents, the period with the highest radiation dose was from the four-month period from day of the accident until July 11, 2011.

[249] Health checkups utilize existing health examinations.

[250] Documents from Fukushima Prefecture

[251] A survey on mental health and living habits was conducted on the residents from the nuclear evacuation zones with a questionnaire.

[252] The budget for the prefecture health monitoring surveys comes from the second supplementary budget "Foundation for protecting health of victims and children from nuclear accidents (78 billion yen)" in 2011 of the Nuclear Facilities Development and Nuclear Fuel Cycle Industry Division, Agency for Natural Resources and Energy of METI.

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 (see 4.4.3, 1).

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.[253] 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.

b. Neglected lessons from Chernobyl

While the national and prefectural governments of Japan did not actively pursue WBC screenings, such screenings were carried out on a daily basis for residents of contaminated areas in Ukraine, Belarus, and Russia following the Chernobyl nuclear accident in 1986. The national governments of these countries also accumulate long-term data and implement exposure-reducing measures based on monitored data.

In these three countries, WBCs are used to conduct annual measurements of internal exposure doses in residents in contaminated areas. Policies have also been implemented for children and pregnant women, including the provision of recreation opportunities (at sanatoriums) in non-contaminated areas, additional holidays, and extended maternity leave.

In Ukraine, health organizations in regions contaminated with radiation are equipped with WBCs, and a system has been established where, in addition to WBC checks during regular health examinations, residents can receive internal exposure screenings on a daily basis. The data from these readings are saved in a database and categorized based on resident attributes—including age, sex, and occupation—and seasonal changes.

Data from this type of internal exposure screening serves as the foundation for determining long-term policy for minimizing the health impacts of radiation. In Ukraine, this data is used to identify high-risk population groups and then implement countermeasures in accordance with the regional attributes and seasons.

In the Kiev district of Ukraine, long-term monitoring results revealed that internal cesium levels that had attenuated over time began to rise again 10 years after the accident.[254] The reason behind the increase was a rise in the number of residents eating locally produced food products. This increase was spurred by the weakening of regulations that allowed for the consumption of locally produced foods as well as a decrease in the supply of uncontaminated foods from other regions, as internal radiation levels had dropped. The situation was also exacerbated by the socioeconomic confusion spawned by the 1991 collapse of the Soviet Union. As a countermeasure to this increase, regulations were again placed on locally produced food products in order to decrease internal exposure levels. Because internal exposure levels had been continuously monitored over more than twenty years, it was possible to detect fluctuations in levels and implement countermeasures.

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

[253] Hearings with individuals related to the Fukushima Prefecture Health Monitoring Survey Committee

[254] Hearings with Ukrainian specialists and individuals related to the Ukrainian Government

[255] Hearings with individuals related to hospitals

[256] Hearings with individuals related to hospitals

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[255] 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.[256]

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.

4. *Need for food screenings and internal exposure level monitoring*

With regard to the screening of food products, while the distribution of food products contaminated beyond the safety limit is being prevented for the most part, the provisional regulations for food products set for a one-year period from March 2011 failed to account for certain nuclear substances and food types.

It is vital to continue monitoring through regular internal exposure screenings in order to reduce the amount of internal exposure to residents in the mid- to long term. Fukushima Prefecture does implement prefectural health monitoring surveys; however, these surveys do not include long-term internal exposure surveying, and there is thus no structure in place to continually monitor residents' long-term internal exposure from radioactive cesium. As there is no plan to analyze internal exposure levels in a comprehensive manner, it is fair to say that there is no collaboration between municipal governments and medical organizations independently conducting WBC surveying, and the efforts of these organizations and the prefectural government are thus incongruent. In order to protect residents from internal exposure, the national or prefectural government must construct a screening scheme for implementing comprehensive internal exposure screenings that include WBC examinations to verify the impacts of low dose exposure.

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.[257] On April 6, 2011, MEXT submitted to NSC the air dose monitoring results for the school grounds of elementary and other schools 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

[257] Hearing with MEXT

[258] NSC Secretariat documents

[259] NSC Secretariat documents

[260] NSC Secretariat documents

should be resumed.[258] 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. [259] 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. [260]

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,[261] MEXT proposed to NSC that the exposure dose be set at 20mSv/year as an approximate benchmark.[262] 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.[263] 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.[264]

Nevertheless, MEXT calculated that the contribution of internal exposure was negligible enough to ignore.[265] 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.[266] 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.[267] Regarding schools with less than 3.8μSv/h, MEXT and NSC concluded that it was acceptable to utilize school buildings and grounds, etc. normally,[268] 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

[261] Japan Radioisotope Association, *Kokusai Hoshasen Bogo Iinkai no 2007 Nen Kankoku* (The 2007 Recommendations of the International Commission on Radiological Protection) (Maruzen, 2009) [in Japanese].

[262] NSC Secretariat documents

[263] NSC Secretariat documents

[264] Press Conference by NSC (April 13, 2011)

[265] Japan Atomic Energy Agency, "Fukushimaken Shogakko ni kansuru Senryo Hyoka (Dose Estimation Regarding Elementary Schools, etc. in Fukushima Prefecture)," April 14, 2011 [in Japanese].

[266] NERHQ, "Fukushimaken-nai no Gakko-to no Kosha-Kotei-to no Riyo Handan ni okeru Zanteiteki Kangaekata (Provisional Concept on Utilization of School Building and School Yard, etc. of Schools in Fukushima Prefecture), April 19, 2011 [in Japanese].

[267] Assuming that children and students, etc. spend 16 hours indoors (in wooden buildings) and 8 hours outdoors, the air dose which will give 20mSv/year is 3.8μSv/h outdoors and 1.52μSv/h indoors. Accordingly, at schools, etc. with an air dose rate below these values, it is believed that the dose received by children and students, etc. will not exceed 20mSv/year through normal activities. NERHQ, "Fukushimaken-nai no Gakko-to no Kosha-Kotei-to no Riyo Handan ni okeru Zanteiteki Kangaekata (Provisional Concept on Utilization of School Building and School Yard, etc. of Schools in Fukushima Prefecture), April 19, 2011 [in Japanese].

[268] NERHQ, "Fukushimaken-nai no Gakko-to no Kosha-Kotei-to no Riyo Handan ni okeru Zanteiteki Kangaekata (Provisional Concept on Utilization of School Building and School Yard, etc. of Schools in Fukushima Prefecture), April 19, 2011 [in Japanese].

[269] Press Conference by Senior Vice Minister of Education, Culture, Sports, Science and Technology, Kan Suzuki (April 19, 2011)

[270] However, the resumption of schools and classes was delayed in cities such as Koriyama City and Soma City due to damage to the school building from the earthquake and tsunami, among other reasons. Hearing with Board of Education of Fukushima municipalities (e.g., Fukushima City, Koriyama City, Date City, Nihonmatsu City, Soma City, Motomiya City, and Aizuwakamatsu City)

hour per day, and also restrictions on the use of sand pits.[269]

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.[270]

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).[271]

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[272] (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.[273] 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[274] and the Japan Medical Association[275] 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. [276]

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[271] NSC Secretariat documents

[272] The establishment of plans permitting exposures exceeding this value was deemed inappropriate. The said value is also the dose or risk level for which protective actions should be planned and optimized. Japan Radioisotope Association, *Kokusai Hoshasen Bogo Iinkai no 2007 Nen Kankoku* (The 2007 Recommendations of the International Commission on Radiological Protection) (Maruzen, September 30, 2009)[in Japanese].

[273]Areas where soil contamination concentration of cesium isotope is more than 15Ci/km^2, or strontium is more than 3.0Ci/km^2, or plutonium is more than 0.1Ci/km^2, and the projected effective dose equivalent received by humans, including the radionuclide transfer factors of plants and other elements, exceeds 5.0mSv/year compared to the level before the accident.

[274] Japan Federation of Bar Associations," 'Fukushimaken-nai no Gakko-to no Kosha-Kotei-to no Riyo Handan ni okeru Zanteiteki Kangaekata ni tsuite' ni kansuru Kaicho Seimei (Statement Concerning the Government's 'Provisional Concept on Utilization of School Building and School Yard, etc. of Schools in Fukushima Prefecture')," April 22, 2011 [in Japanese].

[275] Japan Medical Association, " 'Fukushimaken-nai no Gakko-to no Kosha-Kotei-to no Riyo Handan ni okeru Zanteiteki Kangaekata' ni taisuru Nihon Ishikai no Kenkai (The Opinion of the Japan Medical Association on the 'Provisional Concept on Utilization of School Building and School Yard, etc. of Schools in Fukushima Prefecture')," May 12, 2011 [in Japanese].

[276] Press Conference by Minister of Education, Culture, Sports, Science and Technology, Yoshiaki Takaki (May 24, 2011)

[277] On August 26, 2011, MEXT changed the benchmark value to 1mSv/h, as no schools had air dose measurements exceeding 3.8μSv/h due to, for example, progress made with the decontamination efforts as a result of the subsidies to cover the decontamination costs.

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.[277]

Until then, MEXT's only exposure reduction measure for Fukushima Prefecture was to have school personnel wear dosimeters to confirm the status of exposure.[278] 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.

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[279] 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 (see 4.4.1). 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.[280]

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.[281] 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.[282] The measures that TEPCO had taken for severe accidents were insufficient. As for the radiation protection measures TEPCO

[278] NERHQ, "Fukushimaken-nai no Gakko-to no Kosha-Kotei-to no Riyo Handan ni okeru Zanteiteki Kangaekata (Provisional Concept on Utilization of School Building and School Yard, etc. of Schools in Fukushima Prefecture)," April 19, 2011 [in Japanese].

[279] 146 TEPCO workers and 21 workers of TEPCO partner companies.

[280] TEPCO, "Fukushima Daiichi Genshiryoku Hatsudensho Sagyosha no Hibaku Senryo no Hyoka Jyokyo ni tsuite (Status of Exposure Dose Evaluation for the Workers at Fukushima Daiichi Nuclear Power Plant)," May 31, 2012.

[281] Because the questionnaire could not be conducted for those company workers declined participation in the survey, the sample does not appropriately represent the workers of all companies and is biased. We asked all partner companies of TEPCO to provide the current addresses of the workers who were working at the Fukushima Daiichi Nuclear Power Plant on March 11, 2011. Due to the circumstances of the partner companies, the data we received includes workers who became engaged in restoration efforts after March 11 and they are included in the sample size (approximately 5,500 people). Thus, the survey sample is not an appropriate sample for making a statistical interpretation on the workers who were working at the nuclear power plant on March 11, 2011. Excluding TEPCO workers, most of whose addresses were provided, there is room to verify the reliability of the statistical figures.

[282] Special Provisions on the values set forth in the Ionization Rules and Commercial Reactor Rules were stipulated effective March 14, 2011.

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 (see Reference Material [in Japanese] 4.4.5).

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.

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.[283] After March 16, the advisory team of the Cabinet Secretariat advised the Prime Minister's Office to further increase the upper limit to 500mSv[284] for emergency operations.[285] Discussions on this only took place at the Prime Minister's Office, however, and internal reviews of MHLW were not conducted.[286]

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.[287] 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.

[283] The 250mSv dose falls within the reference level for "Other urgent rescue operations" regarding emergency exposure situations set forth in ICRP's 2007 recommendations.

[284] The 500mSv dose falls within the reference level for urgent operations set forth by ICRP.

[285] Hearing with Cabinet Secretariat personnel

[286] Hearing with MHLW. On December 16, 2011, the special ministerial ordinance of the Ionization Rules was abolished, and the exposure limit for emergency operations in response to this accident was returned to 100mSv. However, as a special measure for workers responding to troubles at nuclear reactor facilities in high dose areas, etc. and workers already engaged in emergency operations, the upper limit for exposure was not modified and was kept at 250mSv. In addition, as an interim measure, for approximately 50 TEPCO employees who have already been exposed to more than 100mSv and have specialized expertise indispensable for operations, such as maintaining the cooling of the nuclear reactor facilities, the exposure limit was set at 250mSv up to April 30, 2012.

[287] Hearing with MHLW; NISA documents

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.[288]

TEPCO explained that from before the accident, efforts were being made to reduce the dose received by nuclear power plant workers.[289] 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.[290] 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[291] 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 [292] 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

[288] TEPCO is believed to have made insufficient efforts to achieve the principle of ALARA (As Low As Reasonably Achievable), one of the principles of radiological protection. The ALARA principle is a concept developed primarily by ICRP regarding the optimization of radiological protection. It sets forth that the possibility of exposure, the number of exposed people, and the amount of their individual doses should be kept as low as reasonably achievable, while taking into account all economic and social factors. Japan Radioisotope Association, *Kokusai Hoshasen Bogo Iinkai no 2007 Nen Kankoku* (The 2007 Recommendations of the International Commission on Radiological Protection) (Maruzen, 2009) [in Japanese].

[289] Hearing with TEPCO radiation managers

[290] Hearing with TEPCO radiation managers

[291] The female worker in her fifties received 5.95mSv external exposure and 13.43mSv internal exposure.

[292] The female worker in her forties received 0.65mSv external exposure and 8.44mSv internal exposure.

[293] The TEPCO worker in his thirties received 80.36mSv external exposure and 590mSv internal exposure.

[294] The TEPCO worker in his forties received 99.73mSv external exposure and 540mSv internal exposure.

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.[293] 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.[294]

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.[295]

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.[296]

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.[297] In less than two months, the three workers received cumulative radiation doses in the range of 289.41 to 458.72mSv.[298]

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.

3. *Lack of radiological protection education for nuclear power plant workers, and radiological protection measures based on onsite discretion*

a. Radiation education

With regard to work conducted in March 2011, TEPCO provided the minimum necessary radiation education at the Onahama Call Center, J Village, and other locations, to workers of affiliated companies involved in emergency operations, including the restoration of the electrical power supply. An approximately 30-minute explanation was provided with the following content.[299]

(i) Dose limit during emergencies: health effects caused by 100mSv exposure, etc.

(ii) Necessary protective gear: full face masks, Tyvek, rubber gloves, etc.

(iii) Management of work hours: how to improve work efficiency to avoid unnecessary over exposure

(iv) On site doses: outdoor air doses at the Fukushima Daiichi Nuclear Power Plant

[295] The TEPCO worker in his fifties received 104.46mSv external exposure and 241.81mSv internal exposure.

[296] Hearing with TEPCO workers

[297] Hearing with TEPCO workers

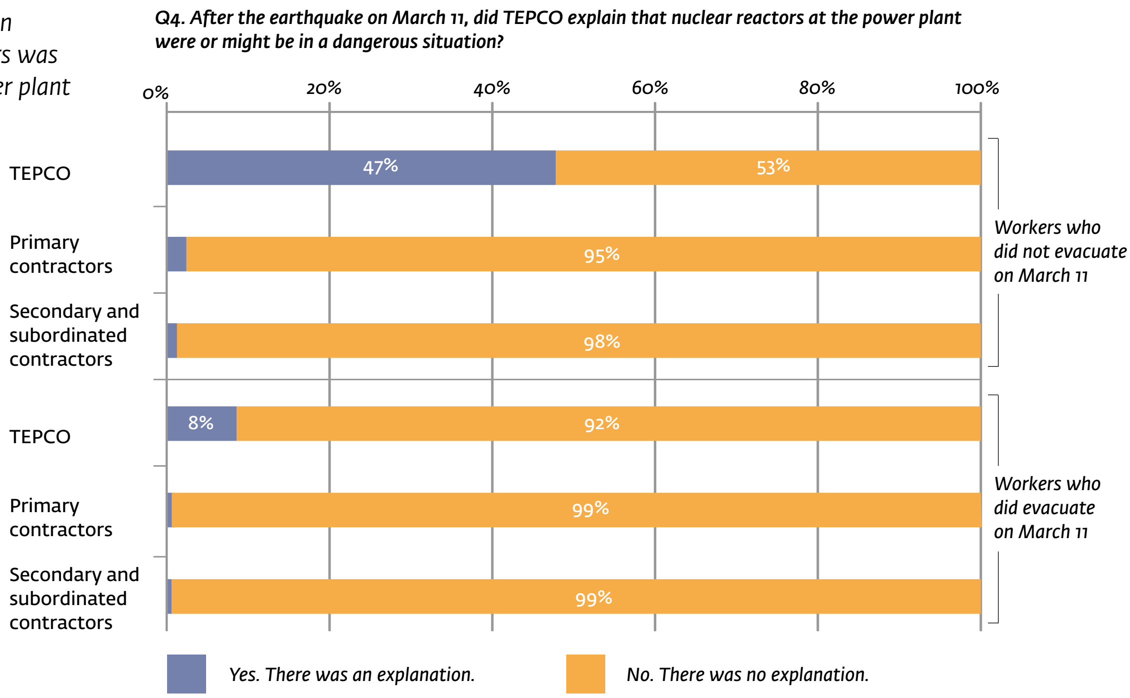
[298] The exposure dose received by the three emergency workers were, respectively: 458.72mSv cumulative (external exposure: 25.67mSv; internal exposure: 433.05mSv); 340.14mSv (external exposure: 12.24mSv; internal exposure: 327.90mSv); and 289.41mSv cumulative (external exposure: 29.75mSv; internal exposure: 259.66mSv).

[299] Hearing with TEPCO radiation managers

[300] Article 52-7 of the Ionization Rules states that, "Should the operator assign workers to handle nuclear fuel material or spent fuel, or substances contaminated as their result, within a controlled area of a nuclear reactor facility, the operator shall provide special education to the aforementioned workers on the following items."
(i) Knowledge of nuclear fuel material or spent fuel or substances contaminated as their result;
(ii) Knowledge of work practices at the nuclear reactor facility;
(iii) Knowledge of the structure of the facilities pertaining to the nuclear reactor facility and handling method;
(iv) Impact of ionization radiation on the human body;
(v) Relevant laws and ordinances; and
(vi) Work practices at the nuclear reactor facility and handing of facilities pertaining to the facility.

[301] In addition, in view of other considerations, including the facts that some workers removed their masks to drink and eat or smoke, that radioactive material is deemed to have leaked in due to the wearing of glasses, and that people other than radiation workers worked at the Fukushima Daiichi plant, we believe the time spent on education and its contents was insufficient.

Figure 4.4.5-1: Whether an explanation of the dangers was given to the nuclear power plant workers



(v) Wearing of mask: how to confirm the mask is on correctly

The Commission does not believe that the above items fully fulfill the requirements[300] of what should be taught to workers working in radiation controlled areas. Missing, for example, are the "relevant laws and ordinances" and the "effects of ionization radiation on human health" as set forth in the Ionization Rules.[301] Furthermore, according to our questionnaire of workers at the Fukushima Daiichi plant, 40 percent of the TEPCO employees who responded to the questionnaire said they received explanations that the nuclear reactors were or might be in a dangerous situation, while most of the workers of affiliated companies said that they had not received an explanation of the situation of the nuclear reactors (see Figure 4.4.5-1).

b. Dose management based on onsite discretion

Because the air dose increased even outside the controlled areas[302] as the accident unfolded, TEPCO provided explanations about the air dose and the significant possibility of exposure to the plant workers who were working outside the seismic isolation building. From around March 13, 2011, radiation managers on site began to hold meetings in the mornings and evenings to share the air dose monitoring information of the worksites. From around March 20, radiation managers created a contamination map of the plant premises, using the monitoring information from the worksites as well as the monitoring information from other locations; through the map, they disclosed information about contamination within the premises.[303]

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

[302] Before the accident, controlled areas were limited to the reactor building and the turbine building. According to Article 3, paragraph 1, items 1 and 2 of the Ionization Rules, a controlled area refers to: (i) An area where effective dose due to external radiation and effective dose due to radioactive material in the air combined may exceed 1.3mSv per a period of three months; and (ii) An area where the surface concentration of radioactive material may exceed one-tenth of the limit listed in Appended Table 3 ([a] 4Bq/cm2 per radioactive isotope which releases alpha rays; and [b] 40Bq/cm2 per radioactive isotope which does not release alpha rays).

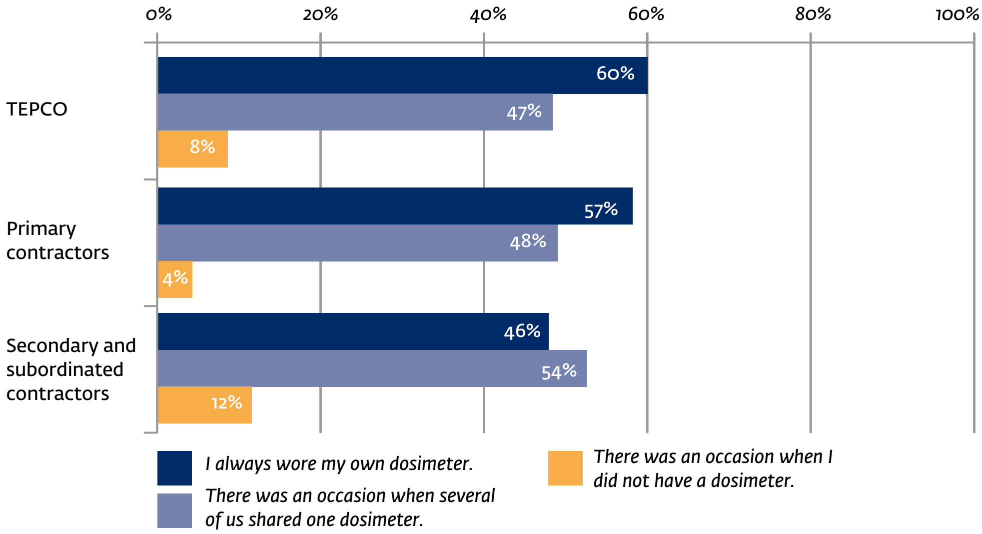
[303] Hearing with TEPCO radiation managers

[304] TEPCO requested the support of other electric power companies through FEPC and received a shipment of approximately 450 APDs by March 18, 2011. However, because the APDs were not equipped with alarms, they were not usable. On March 31, 2011, 100 APCs were delivered through an emergency purchase. On April 1, shipment of approximately 500 APDs was received from the KK site. As a result, the number of APDs available rose to approximately 920. The Source: TEPCO documents

[305] Hearing with TEPCO radiation managers

[306] Hearing with TEPCO radiation managers

Figure 4.4.5-2: Management of the dose received by nuclear power plant workers (multiple answers allowed)



shifts. However, many were washed away in the tsunami, reducing the number of usable APDs to approximately 320.[304] 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.[305]

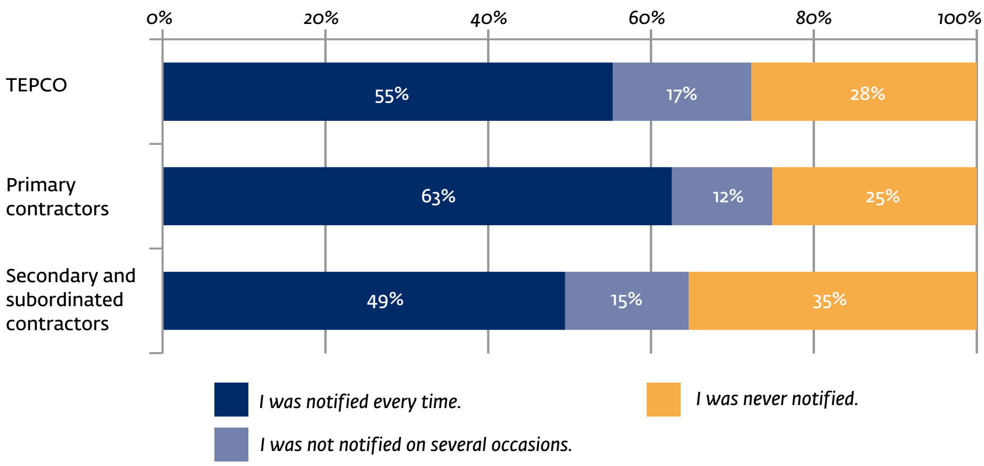
At times, TEPCO could not gauge the dose received by every worker, and in some cases, one APD would be loaned to a group. In principle, when loaning the APD to workers, the radiation manager on site would conduct interviews about the work each group would be performing, in order to determine whether to loan one APD to the group or to loan APDs to individuals. [306]

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.[307]

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

Figure 4.4.5-3: Cumulative Exposure Dose



reported having their own APD. A small percentage of workers, however, reported that no dosimeters had been distributed to them.

Using APDs to manage the dose received by workers as a group does not necessarily constitute a violation of the law.[308] But there was no system in place to ensure that radiation managers on site appropriately determined their distribution to individuals

[307] Hearing with TEPCO workers

[308] According to Article 45, paragraphs 2 and 3 of the Ionization Rules, operators can figure out, among others, the effective dose of exposure of workers through calculation.

or groups. After the accident, radiation managers on site managed APD data by hand or with spreadsheets that shows 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.

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 time-consuming 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.[309] The short supply of charcoal masks attributable to TEPCO's insufficient preparations for a possible accident is another problem to tackle.

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

[309] Hearing with TEPCO radiation managers

[310] Ministry of Emergency Situations of Ukraine, *Twenty-five Years after Chernobyl Accident: Safety for the Future* (KiM, 2011), 178.

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.[310]

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.[311]

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.[312]

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,[313] with some people revealing they were taking tranquilizers.[314] 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. [315]

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.[316] 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),[317] 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.

4.5 Environmental contamination and prolonged

[311] Volodymyr Holosha, Head of the State Agency of Ukraine for Exclusion Zone Management, Ministry of Emergency Situations, at the 7th NAIIC Commission meeting

[312] NSC, "Genshiryoku Saigai-ji ni okeru Mentaru Herusu Taisaku no Arikata ni tsuite (Measures for Mental Health Care in a Nuclear Emergency)," November 2002 [in Japanese].

[313] "It is impossible to change our current circumstances, no matter what I write. I would like someone to tell me where we, who have lost our home towns and villages, should go. Even in the unlikely event that I am able to return, to see the ruins of the home I left when I was facing death, would surely be enough to shock me to death. I have lost everything and have no more tears to shed. The only thing I can do is pray fervently that a similar accident never occurs again. I feel a great deal of mental strain. Today, one year on from the accident, my symptoms have become more severe." Extract from a questionnaire implemented by NAIIC.

[314] "In addition to reaching my mental and physical limits, I was unable to sleep in a place that was strange and unknown to me without the aid of tranquilizers. In addition to saying that the government response was too slow, I also don't want to be kept waiting for the disclosure of information that is free from lies and deceit which make me expect good things." Extract from a questionnaire implemented by NAIIC.

[315] Hearing with a medical doctor

[316] MHLW, "Hisai sareta Kata no Kokoro no Kea ni tsuite (Mental Health Care for the Disaster Victims)," December 27, 2011 [in Japanese].

[317] The most common symptoms include flashbacks, headaches, stomach aches and nausea.

decontamination issues

Once radioactive substances are released, they continue to affect the environment over the long term. The government should therefore implement environmental monitoring based on this premise. It can be observed from the Chernobyl nuclear accident that radioactive substances remain for many years over wide areas of mountains and forests, and their levels do not significantly decrease for many decades. In addition, these radioactive substances are washed out and transferred elsewhere due to rainfall, ending up in places, like lakes, where they accumulate in relatively high concentrations. The government should promptly address these issues with a long-term response.

The government is currently engaged in decontamination operations on a massive scale, and the methods for decontamination vary greatly, depending on the characteristics of the area being decontaminated. As the effects and limitations of decontamination are closely related to issues such as the return of residents and their compensation, residents' opinions tend to be largely divided, even within the community itself.

In regions where decontamination is being implemented, one of the most significant challenges cited is securing temporary storage sites for contaminated earth. As a result of close consultation between municipalities and residents, there are many areas where temporary storage sites have been successfully established. It is desirable that not only the central and local governments follow decontamination plans that have been formulated in accordance with formally prescribed methods and guidelines, but that in the process, efforts be made to communicate with residents and provide them with information that will help them make informed decisions, which will enable the implementation of measures that correspond to residents' needs.

4.5.1 Environmental contamination

1. *Accumulation of radioactive substances in the environment*

The majority of the radioactive material released into the environment was dispersed into the atmosphere. Later, it fell to earth with precipitation, and settled on the soil, in lakes and the sea. This cycle is then repeated and radioactive materials gradually accumulate. Once radioactive materials have accumulated, it is generally thought that it takes longer for them to decay, thus prolonging contamination.[318] This accident also caused environmental contamination over a wide area within Fukushima Prefecture there are signs that radioactive materials have accumulated in forests and on river and lake beds, thus exacerbating concerns that, as with the Chernobyl accident, contamination will be prolonged.

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.[319] 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,[320] resulting in extremely small volumes finding their way into the groundwater. A report stated that in the

[318] Hearings with experts

[319] IAEA, "Environmental Consequences of the Chernobyl Accident and their Remediation: Twenty Years of Experience, Report of the Chernobyl Forum Expert Group 'Environment'," 2006.

[320] Hearings with experts

[321] IAEA, "Environmental Consequences of the Chernobyl Accident and their Remediation: Twenty Years of Experience, Report of the Chernobyl Forum Expert Group 'Environment'," 2006.

[322] MEXT, "Tokyo Denryoku Kabushikigaisha Fukushima Daiichi Genshiryoku Hatsudensho no Jiko ni Tomonai Hoshutsu sareta Hoshasei Busshitsu no Bunpu Jyokyo-to ni kansuru Chosa Kenkyu Kekka ni tsuite (Results of the Research on Distribution of Radioactive Substances Discharged by the Accident at TEPCO's Fukushima Daiichi NPP)," March 13, 2012 [in Japanese].

forests close to the Chernobyl nuclear power plant, the emission of cesium 137 from 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 any decrease in the radiation concentration.[321] In a study conducted by MEXT in the 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.[322] 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

Table 4.5.1-1: Status of contamination of river and lake beds

Location	Nuclide	June 2011 figures	March 2012 figures
River bed	Cesium 134	48 -14,000	ND -38,000
	Cesium 137	51-16,000	ND -54,000

Location	Nuclide	Nov. 2011 figures	March 2012 figures
Lake bed	Cesium 134	ND -17,000	ND -110,000
	Cesium 137	ND -20,000	17 -150,000

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.[323]

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.[324] Furthermore, continued monitoring has revealed that there are highly contaminated places. (See Table 4.5.1-1.) [325]

2. *Impact of environmental contamination on living areas and countermeasures*

The radioactive materials in the environment present a problem in that direct exposure to environmental radiation and oral intake through contaminated food products could affect the health of residents over the long term. For example, in Nihonmatsu, which is an urban area surrounded by forests, the impact of radiation from the mountains and forest areas that have not been subject to decontamination operations is significant. The homes that are close to these mountains and forests are facing a problem

[323] IAEA, "Environmental Consequences of the Chernobyl Accident and their Remediation: Twenty Years of Experience, Report of the Chernobyl Forum Expert Group 'Environment'," 2006.

[324] The standards contained in Article 20 of the Act on Special Measures Concerning Handling of Radioactive Pollution are stipulated in Article 23 of the enforcement ordinance of the law. When the combined total of cesium 134 and cesium 137 exceeds 8000Bq/kg, management of waste is required based on the aforementioned article.

[325] There are multiple sampling points for river and lake beds and the above table shows the range of contamination concentration among the various sampling points. For river beds, in the June 2011 figures there were 29 sampling points, and 113 points in March 2012. For lake beds, in November 2011 there were 46 sampling points and in March 2012 there were 25. MOE, "Higashi Nihon Daishinsai no Hisaichi ni okeru Hoshasei Busshitsu Kanren no Kankyo Chosa ni tsuite (Environmental Monitoring of the Area Stricken by the Great East Japan Earthquake Related to Radioactive Materials) [in Japanese].

[326] Hearings with staff of Nihonmatsu City government

[327] Hearings with experts on the Chernobyl nuclear accident

[328] Hearing with experts. In Bryansk Oblast, which was a region of Russia contaminated by the Chernobyl accident, a forest fire in August 2010 caused a danger that radioactive substances would be re-dispersed. *International Business Times*, August 11, 2010. Accessed June 22, 2012, jp.ibtimes.com/article/biznews/100812/58846.html.

in that it will be difficult to reduce the air dose rate around the houses just through the decontamination of areas near the houses.[326] In Ukraine, the contamination of forests close to the Chernobyl nuclear power plant resulted in mushrooms and berries being contaminated due to the transfer of radioactive materials from soil and trees.[327]

In addition to the above-mentioned direct impact on human beings, it must be kept in mind that the radioactive materials in the environment have the other potential to be spread further by physical movement and ecological processes, which could create a secondary area of contamination. A specific example of this secondary contamination would be the further dispersal of radioactive substances due to forest fires, etc.[328] The Chernobyl Radio-Ecological Center that is located in the Chernobyl Exclusion Zone in Ukraine engages in 24-hour monitoring of forests, given the possibility that a forest fire could cause re-dispersal of radioactive materials.[329] MEXT, the Ministry of the Environment and the Forestry Agency have joined Fukushima Prefecture in monitoring contamination of radioactive materials in the environment. It will be necessary to continue to enhance and expand this monitoring structure.

4.5.2 Decontamination issues

The decontamination operations implemented up to June 2012 have shown that while they do actually reduce the radiation dose, the effect is limited. The main measure has been the removal of topsoil, and, in schoolyards, parks and residential areas, and where this has taken place, there has been a reduction in the dose. Approximately three months after removal work was first undertaken, the reduction effect was being maintained. However, in some agricultural areas where topsoil removal is difficult and forests, the dose reduction that can be achieved through decontamination is limited.

The restoration of the infrastructure for daily life is not as easy as decontamination operations. The government should give due consideration to the restoration of the daily living infrastructure for residents, examining the effects and limitations of decontamination in reducing the dose and implementing support measures. The government and the local government should then formulate and announce the selection criteria for decontamination locations and a work schedule.

Even when the decontamination of contaminated areas is completed, it will not necessarily mean that residents can immediately return to their homes. The residents' right to self-determination should be respected, and it will be necessary to create comprehensive exposure reduction measures that take into account local circumstances and the wishes of residents, thus enabling all residents to choose for themselves between a return home following decontamination, or relocation, or compensation.

1. *Purpose of decontamination and government policy*

The health impacts of low-dose radiation exposure have not been sufficiently clarified scientifically. However, from the perspective of radiation protection, it is preferable to reduce exposure to the greatest degree possible. The methods to achieve this are either to move away from the radioactive areas that have high dose rates (evacuation), or to remove the radioactive substances from the living environment (decontamination).

With regard to decontamination, the NERHQ issued a Basic Policy for Emergency Response on Decontamination Work in August 2011. Under this basic policy, as a specific target for decontamination work, the government aims to reduce the estimated

[329] Hearings with Ukrainian government officials, etc.

[330] According to the estimate of NERHQ, annual exposure dose is expected to decrease by about 40 percent in two years from the current level because of physical attenuation of radioactive materials as well as natural attenuation due to wind and weather. NERHQ, "Josen ni kansuru Kinkyu Jisshi Kihon Hoshin (Basic Policy for Emergency Response on Decontamination Work)," August 26, 2011 [in Japanese].

[331] Act on Special Measures Concerning the Handling of Environment Pollution by Radioactive Materials Discharged by Nuclear Power Station Associated with the Tohoku District – Off the Pacific Ocean Earthquake that Occurred on March 11, 2011 (Act No.110 of August 30, 2011).

[332] Special areas for decontamination refers to regions in the restricted area (within a 20km radius of the power plant) and the deliberate evacuation area. As MOE is responsible for decontamination in these areas they are called as direct jurisdiction areas.

[333] Priority areas with contamination refers to locations where the air dose rate is greater than 0.23μSv per hour. As it is those areas where the local governments and not MOE that are responsible for these operations, they are called as non-direct jurisdiction areas.

annual exposure dose for the general public by approximately 50 percent in radiation-contaminated areas within two years, including at least 10 percent through decontamination work.[330] In addition, with regard to children, the basic policy sets out a target to reduce the estimated annual exposure dose for children by approximately 60 percent within two years, including at least 20 percent through decontamination work. Currently decontamination is being implemented based on the Act on Special Measures concerning the Handling of Environment Pollution by Radioactive Materials,[331] under a dual framework whereby the Ministry of the Environment is responsible for decontamination in special areas for decontamination[332] and each local government is responsible for priority areas with contamination.[333]

2. *Dose reduction effects and limitations of decontamination in priority areas with contamination*

Of the two designations described above, this Commission held onsite surveys of the priority areas with contamination, where most decontamination operations are being implemented. Based on the onsite surveys, the following sets out the methods, effects and limitations of decontamination for each site surveyed.

a. Decontamination of schools, parks, houses, roads and gutters

(i) Decontamination of schools and parks

Decontamination of schools and parks was given the highest priority, to reduce the exposure of children to radiation. The decontamination of schoolyards and parks generally involved the removal of topsoil and replacing it with a layer of uncontaminated earth. Specifically, heavy machinery was used to remove a 5cm layer of topsoil, after which a new layer of soil was used to cover the site. In many cases, the topsoil removed was buried in a corner of the site in question, where it is being managed provisionally until a decision on a temporary storage site can be made. In the cases of elementary schools in Nihonmatsu and Minamisoma,[334] the removed topsoil was buried in a hole approximately 2m deep, and covered with a new layer of topsoil approximately 1m in depth. As a result, the radiation exposure dose outside 23 elementary and junior high schools in Nihonmatsu has decreased. Prior to decontamination the average dose was 2.42μSv/h; following decontamination this figure was reduced to an average of 0.58μSv/h.[335] The 33 schools and educational facilities in Minamisoma also saw the average dose outside schools reduce from 0.74μSv/h to 0.17μSv/h.[336]

This method of removing topsoil and covering with earth is recognized to have a definite effect. Ongoing post-decontamination monitoring has been implemented and it has confirmed that the decontamination effect remains. However, the wooden play equipment and ropes at schools, as well as the drains around pool areas where radioactive substances tend to accumulate have shown high dose rates. These areas will continue to present a challenge.

(ii) Decontamination of houses

The decontamination of houses was carried out by washing the roofs, guttering and side drains, external walls, gardens, railings and fences, etc. Fallen leaves were cleared; weeds, grasses and topsoil were removed.

Table 4.5.2-1 shows examples of the decontamination operations at three typical houses in Date.[337] The measurements varied depending on the positions measured around the houses however a reduction effect in the dose rate can generally be seen following decontamination, with the exception of the rear of House B. In many cases, the volume of accumulated radiation was high both in and beneath guttering, and it can be seen that washing these locations had a particularly strong reduction

[334] Hearings with staff of Nihonmatsu City government and Minamisoma City government

[335] Hearings with staff of Nihonmatsu City government

[336] Hearings with staff of Minamisoma City government

[337] Hearings with staff of Date City government

[338] Hearings with staff of Date City government

[339] Hearing with staff of Nihonmatsu City government

Table 4.5.2-1: Examples of decontamination effect in Date (Dosage at ground level; Unit: μSv/h)

	House A			House B			House C		
	Before decontamination	After decontamination	Three months later	Before decontamination	After decontamination	Three months later	Before decontamination	After decontamination	Three months later
Front of entrance porch	2.2-3.3	0.8-1.0	0.8	0.8-10.9	0.9-2.8	0.4-3.5	3.2	0.8	0.7
Garden	2.5-4.1	1.5-2.5	1.2-1.3	-	-	-	2.0-29.5	0.6-5.5	0.5-4.8
Behind house	1.0-4.3	0.7-3.4	0.7-3.2	1.2-24.0	0.5-31.1	0.8-8.2	2.6-46.2	0.7-7.6	0.9-8.5
In and beneath guttering	6.5	0.9	2.9	97.4	6.9	1.7	39.3	1.7	1.0

effect.[338] In addition, the survey confirmed that three months after decontamination, the effects of decontamination were largely maintained, with the exception of the location beneath the guttering in House A.

Furthermore, in the ordinary housing areas in Nihonmatsu a dose reduction effect due to decontamination was confirmed, amounting to 52 percent for roofs and guttering, 55 percent for drains and gardens, and 41 percent for parking area lots. [339]

According to our survey, differences in the dose reduction effect depended on the environment in which the houses were located. For example, for houses in areas surrounded by mountains and forests, the dose reduction was limited, since the impact of radiation from the mountains and forests on the air dose rate is considerable, even after decontamination.

(iii) Decontamination of roads and gutters

Roads were decontaminated by high-pressure washing of paved surfaces and the removal of roadside weeds, grass and any accumulated materials found in roadside drains and gutters. In Nihonmatsu, a priority was put on decontaminating roadside gutters rather than paved surfaces.[340] It was confirmed that the removal of materials accumulated in roadside gutters had a big effect on dose reduction. It was felt that washing paved surfaces might result in run-off entering the water supply network, raising concerns about water contamination. In the case of Nihonmatsu, the decontamination of roads resulted in dose reduction from an average 5.8μSv per hour to an average 0.8μSv per hour.

In Kawauchi, as the roads are used to transport waste materials from decontaminated houses and other facilities, it was decided to decontaminate houses first, followed by the roads around the decontaminated houses. [341]

b. Decontamination of agricultural areas and forests

(i) Decontamination of agricultural areas

In terms of cost-effectiveness, there is no available method that is efficient for the decontamination of agricultural areas (including rice paddies, fields and grazing land, etc.). If topsoil were to be removed in the same way that is done for schoolyards and houses, a certain reduction effect could be expected, but it would create a further challenge of dealing with vast quantities of contaminated earth. Although deep plowing to replace topsoil with subsoil has been carried out in many areas, this serves only to dilute and disperse the radioactive materials rather than remove them. This method does not result in a reduction in the overall volume of radioactive materials.

In an interview conducted by this Commission with an agricultural expert from

[340] Hearing with staff of Nihonmatsu City government

[341] Hearing with staff of Kawauchi Village government

[342] Hearing with an expert on the Chernobyl nuclear accident

[343] IAEA, "Environmental Consequences of the Chernobyl Accident and their Remediation: Twenty Years of Experience, Report of the Chernobyl Forum Expert Group 'Environment'," 2006.

[344] Focus was placed on the fact that the cesium transfer factors (the proportion of radioactive substances that are absorbed by plants from the soil) vary according to the type of plant. Farmers thus converted to crops that did not have high transfer factors and implemented soil improvement, using rapeseed, known to adsorb cesium.

Ukraine, it was noted that in Ukraine no active measures were taken to decontaminate agricultural areas after the Chernobyl accident.[342] It was thought that implementing decontamination of agricultural areas in Ukraine would not be appropriate, as the removal of topsoil would be costly and result in a loss of soil fertility. Securing a location for the burial of the contaminated earth would create further ecological problems.[343] Ukraine focused on the premise that the contamination of agricultural areas would not necessarily lead to the contamination of food products, and innovative methods and means were put in place to utilize the land. These methods did not include decontamination, but included methods of improving the soil through the heavy use of potassium, a choice of crops based on the proportion of radioactive materials they can absorb,[344] dairy and cattle farming methods that would reduce the concentrations of cesium present in livestock,[345] and usage of cesium adsorbents.[346] The farmers there have come up with innovative ways of producing food products with low levels of contamination. [347]

(ii) Decontamination of forests

As with agricultural areas, there is currently no effective method to decontaminate forests. If branch and leaf cuttings were taken away, and topsoil removed and covered over a wide area, a certain reduction in dose could be expected. The area of forest coverage, however, is even greater than that of agricultural areas, so such a method would be impossible, for all intents and purposes. Using this method would also add the possibility of landslides.[348]

Currently branch clippings and leaves are being removed from the forest edge up to approximately 20m into the forest. This is limited to areas of forest that are close to dwellings. However, wind and rain can cause the transfer of radioactive materials from the forests into dwelling areas and this is a cause for concern for some people.

3. *Various issues arising from decontamination*

a. Issue of the disposal of radioactive waste gathered during the removal of topsoil

At present the most effective decontamination method or reducing the dose rate is the removal of topsoil. However, this method creates vast quantities of radioactive waste.

The Ministry of the Environment has announced a construction target for interim storage facilities that will manage radioactive waste within three years. After 30 years the materials stored at these interim storage facilities will be processed outside Fukushima Prefecture. However, decisions regarding these interim storage facilities are proving difficult.[349]

b. Issue of temporary storage sites

Local governments are constructing temporary storage sites where radioactive waste from the decontamination operations are expected to be stored for the approximate three years or so it will take for the interim storage facilities to be completed. However, because a final decision on the location of the interim storage facilities is proving difficult and there is currently no forecast for when they will be constructed, there are concerns from local governments and residents alike that materials in the

[345] This means that, by feeding cattle feed that was not contaminated with cesium approximately three months prior to their processing, it was possible to raise dairy and beef cows with reduced cesium concentrations in their bodies.

[346] This means that by feeding cattle cesium adsorbents such as Prussian Blue it was possible to reduce the amounts of cesium absorbed by dairy and beef cattle.

[347] Hearing with the Ukrainian Institute of Agricultural Radiology; in the same way as Ukraine, agricultural areas in Belarus and Russia, which were also contaminated due to the Chernobyl accident, are employing similar methods.

[348] MOE, "Josen Kankei Gaidorain (Decontamination Guideline)," December 2011 [in Japanese].

[349] Currently, it is expected that a total of 15,000,000 to 28,000,000 m^3 (equivalent to 12 to 23 times the size of Tokyo Dome) of radioactive waste will be generated, requiring interim storage facilities that cover an area of 3 to 5 km^2. As of March 2012, MOE is following a plan to split the storage facilities into three locations in Futaba Town, Okuma Town and Naraha Town, but a final decision runs into difficulties.

[350] Hearings with related local governments in Fukushima Prefecture

temporary storage sites will continue to be stored there for periods longer than three years. These concerns have resulted in a deadlock over the selection of temporary storage sites in some cases.[350] The waste materials are now being stored provisionally in various locations, and dealing with this waste is a common problem for all local governments.

Initially local governments proceeded with plans to establish temporary storage sites on publicly owned land. However, in many regions it was difficult to gain the support of local residents, forcing local governments to reconsider the locations. The local governments then provided explanations to residents on numerous occasions and after gaining their support set about constructing temporary storage sites within their administrative jurisdiction. In some cases, however, the radioactive waste is being buried on the grounds of each dwelling as a provisional measure, when temporary storage sites cannot be secured.

The challenge of securing temporary storage sites is the single largest area of dispute in international decontamination efforts as well. The United States Environmental Protection Agency has said that explanations and negotiations with residents regarding the establishment of temporary storage sites takes up about half the working hours of the division responsible for decontamination.[351]

4. *Necessity for measures to reduce radiation exposure in addition to decontamination operations*

Although decontamination has a confirmed effect, there are areas where the radiation dose reduction is limited, such as for dwellings in areas surrounded by mountains and forests. In the Watari and Onami districts of Fukushima City, which are both areas of dense housing near forests, the air dose rate due to radiation from the forests is high, even within the Fukushima City limits. For such areas, it is necessary to consider exposure reduction measures other than decontamination.

In order to reduce the exposure to radiation to children and pregnant women in such areas, several temporary evacuation projects are in place. These projects are similar to those that have been going on in the Chernobyl area where children are sent to sanatoriums to recuperate (see 4.4.3). At a time when vast amounts of money are being poured into decontamination efforts, more should be done to promote temporary evacuation projects.

5. *Status of decontamination in special areas for decontamination*

As noted above, decontamination is being implemented in two ways, special areas for decontamination and areas of priority contamination. The areas covered by the restricted area and deliberate evacuation area are considered to be special areas for decontamination. In these areas, it is the responsibility of the Ministry of the Environment to implement decontamination; these areas are separate from the areas of priority contamination that are dealt with by local governments. Other than certain model projects and advanced decontamination operations, no other decontamination programs have been implemented in the special areas for decontamination.

The special areas for decontamination cover locations where the cumulative annual dose of radiation is greater than 20mSv and, in principle, all the residents have been evacuated from these areas. There is no uniform opinion among former residents regarding the future of these areas, and opinions range from those who prefer decontamination and an early return to their homes, to those who are requesting support other than decontamination operations. The following comments are excerpts from the free comment space in the questionnaire distributed to residents by this Commission.

a. Opinions in favor of decontamination (and an early return to homes and businesses)

"If the government is really intent on enabling residents to return, they should concentrate all their efforts on decontamination quickly." (Resident of Futaba)

[351] Hearings with experts from the United States Environmental Protection Agency

"I want the government to do a full-fledged decontamination and return everything back to the way it was." (Resident of Kawamata)

"Please return Futaba and Fukushima back to how they were by decontaminating as soon as possible. I cannot wait five or ten years. I am tired of my current way of living. I want to go home as soon as possible." (Resident of Naraha)

b. Opinions of those seeking support other than decontamination

"Rather than decontamination, what I would like is a place where I can relax and live my life. . . . I would like for someone to build me even a small house somewhere." (Resident of Futaba)

"I really want to return to my town, but we all recognize that is not realistic. Rather than decontamination, what I want is the surety of a compensation payment. Rather than large general contractors benefiting (through decontamination operations), what the residents would like is funding (compensation), to enable them to move to another area." (Resident of Futaba)

"I don't believe that decontamination is necessary in Okuma. I think that rather than wasting money it would be better to spend the money in a different way. I want a decision to be made as soon as possible to the direction the residents will take." (Resident of Okuma)

As can be seen from the above, although the radiation dose can be reduced a certain degree through decontamination, it is clear that decontamination has its limitations, and the residents accordingly have varying opinions.

6. *The future of decontamination and the residents' right of choice*

The restoration of the infrastructures necessary for daily life is not as easy as merely completing decontamination operations. The government should give due consideration to the restoration of daily living infrastructures for residents, examining the effects and limitations of decontamination in reducing the dose rate and implementing support measures for residents. The government and the local government should formulate and announce selection criteria for decontamination locations and a work schedule for decontamination.

Furthermore, regardless of whether or not the government issued evacuation instructions, a system needs to be created to provide the necessary support in an equal and appropriate manner both for those who evacuated and those who chose not to evacuate. The act[352] to support people affected by the accident is a step in that direction; however, specific policies and budgetary allocations relating to this legislation have yet to be formulated. The residents' right to self-determination should be respected; it will be necessary to create comprehensive exposure reduction measures that take into account local circumstances and the wishes of residents, thus enabling all residents to make their own decisions and choose between returning home following decontamination, relocation, or compensation.

[352] Act on Promoting Measures to Support the Livelihoods of People Affected by the TEPCO Nuclear Power Station Accident for Protecting the Daily Lives of Residents, Including Children (Enacted June 21, 2012).