emergency measures should be taken, including a review of emergency evacuation preparation zones. In response to this request, the NSC provided "Initiatives to lift the Evacuation-Prepared Area in Case of Emergency designation for the TEPCO Fukushima Dai-ichi NPS Accident" the same day. On August 9, based on this reply, the NERHQ decided to prepare a "Review of evacuation areas," which addressed the following three points to be confirmed: (i) the safety of nuclear power reactor facilities, (ii) a decrease of the air radiation dose rate, and (iii) restoring of the public service functions and infrastructure.

On the same day, NISA referenced the report "Regarding the confirmation of safety of nuclear power reactor facilities of the TEPCO Fukushima Dai-ichi NPS" stating that it was unlikely that a hydrogen explosion would occur and unlikely that the nuclear reactor cooling system might fail due to following countermwasures taken such as the filling nitrogen into the primary containment vessel and the establishment of a system of circulation cooling including the treatment of accumulated drainage water in reactor buildings, a multiplexing of electric power supply, the relocation of an emergency power source to higher ground, and the establishment of sea wall; and that even if the nuclear reactor cooling system did fail, the effect of radiation on the emergency evacuation preparation zones might be sufficiently lower than the index provided in the NE Guideline.

Based on "the Radiation Monitoring Action Plan for Homecoming regarding Evacuation Prepared Areas in Case of an Emergency," which was established on July 25, MEXT conducted various monitoring activities in Minami-soma-shi, Tamura-shi, Kawauchi-mura, Hirono-machi and Naraha-machi. As a result, it was discovered that measurement points, including main spots near schools, in all of the municipalities did not exceed 1.9μSv/h[45]. MEXT made an announced this on August 9[46].

Additionally, on September 19, all cities, towns and villages in the emergency evacuation preparation zones created disaster recovery programs and submitted them to the NERHQ.

Based on these disaster recovery programs, the NERHQ decided that conditions (i) to (iii) for lifting the emergency evacuation preparation zones were met.

[45] Areas in some parts of Minami-soma-shi, Tamura-shi and Kawauchi-mura showed measured values of air radiation dose rates exceeding 3.0μSv/h. However, it was established that the measured values were only found in limited areas and that lifting the emergency evacuation preparation zones should not be dependant on them.

[46] A brief announcement was promptly made on August 9. A more detailed version was published on August 16.

The NERHQ exchanged opinions on the lifting of emergency evacuation preparation zones and disaster recovery with the leaders of the cities, towns and villages concerned and then, on September 30, asked the NSC its advice on the lifting of emergency evacuation preparation zones. On the same day, the NSC replied that it had no objection to the NERHQ' ideas with conditions that appropriate measures should be taken on radiation monitoring as well as decontamination activities. On the same day, the NERHQ issued a directive and statement that the emergency evacuation preparation zones of the cities, towns and villages should be lifted.

4. Measures taken to address the risk of radiation exposure

(1) Radiation control standards

a. International Commission on Radiological Protection (ICRP)

ICRP is an international nonprofit organization made up of a committee of experts that was founded by the International Society of Radiology and provides radiological practitioners with recommendations and guidance on radiation protection. It was restructured to be responsible for a wider range of radiation protection outside the medical science and given its present name in 1950.

ICRP has established a framework for radiological protection based on data derived from actual facts and the impact of radiation exposure collected and scrutinized by the UN Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) and provides advice on radiation exposure limits for radiation control. ICRP has established a concept of radiation exposure dose to correlate with risks of human health and also provides recommendations on how to estimate the radiation exposure dose for various situations. ICRP works together with UNSCEAR, the World Health Organization (WHO) and the IAEA. For example, the IAEA respects ICRP recommendations and assists member countries to participate in consensus-building efforts and establishes the international basic safety standards for radiation protection to be implemented in member countries.

The first IAEA publication (Pub. 1) containing its recommendations, which were approved in the previous year of 1958, was issued in 1959. The IAEA's general basic recommendations that succeeded the first one were Pub. 6 (1964), Pub. 9 (1966), Pub. 29

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(1977), Pub. 60 (1990) and Pub. 103 (2007).

b. ICRP standards

ICRP recommendations classify the harmful effects of radiation exposure on human health into two categories: "deterministic effects" and "stochastic effects." A "deterministic effect" is an effect or serious impact such as death or cell malfunction that deterministiccally occur with high radiation dose. A "stochastic effect" is an occurrence of cancer or hereditary effects (hereinafter referred to as "cancer, etc.") that is induced by the gene (DNA) mutation and stochastically caused by relatively low radiationdose (refer to Pub. 103, (55)). No cases of the occurrence of a deterministic effect were confirmed by the nuclear accident at the Fukushima Dai-ichi NPS. The ICRP concept is briefly described only in terms of "stochastic effects" as follows:

Epidemiological data, on which ICRP recommendations are based, have mainly been collected and analyzed from a life span study (hereinafter referred to as "Life Span Study") of atomic bomb survivors in Hiroshima and Nagasaki conducted by the Japan-US joint Radiation Effects Research Foundation (RERF, the Atomic Bomb Casualty Commission, or ABCC until 1975) since 1950 (refer to Pub. 103, A.4.4). The results of this research study based on that data show that, with regards to nuclear atomic bomb survivors who were exposed to more than 100mSv of radiation dose from an atomic bomb, there is a statistically significant relationship between radiation dose and cancer rates (the higher the radiation dose, the higher the cancer rate). On the other hand, with regards to atomic bomb survivors who were exposed to less than 100mSv of radiation dose from an atomic bomb, it has not yet been concluded due to insufficient data as to whether there is a clear relationship between the radiation dose and cancer rate. The ICRP recommendation, however, is based on a model (hypothetical theory) that, from a conservative standpoint, there is a proportional relationship between the radiation doses and cancer rates (a recommendation in 2007, Pub. 103, 3.2.1). Additionally, a recommendation in 1990 (Pub. 60, 3.4.2) was also based on premise of a proportional relationships both for low radiation doses and low radiation dose rates. This model, which is not based on the so-called threshold theory that low radiation dose has no radiation effect, is called a

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linear-non-threshold dose-response (LNT) model, or linear model (hereinafter referred to as "LNT model"[47]). Additionally, according to the LNT model, in high radiation doseradiation dose as well as well as in low radiationradiation dose dose, cancer rates increase or decrease depending on radiation dose. Hence, if radiation exposure does not have any other merits (for example, economic or medical), then radiation exposure is not justified. And, even if the radiation exposure is justified, such radiation radiation doses should be controlled to be as low as reasonably achievable ("Principle of Justification," "Principle of Optimization of Protection", Pub. 103, 5.6).

Based on this concept, the ICRP classifies situations where people might be exposed to radiation from a nuclear reactor accident into two types: "radiation emergency situations"[48] and "existing exposure situations,"[49] and provides the recommendation for an "radiation emergency situation" that: (i) for occupational exposure, the reference level of life-saving operations (informed volunteers only) should be "no restrictions on exposure" the reference level[50] for other urgent rescue operations should be 1,000mSv or below 500mSv[51], and the reference level of other rescue operations should be "below 100mSv"; and (ii) for public exposure, the reference level should be 20mSv to 100mSv per year[52].

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[47] The "LNT" in "LNT model" stands for "Linear Nonthreshold Dose Response."

[48] An "radiation emergency situation" is described as one that arises as the result of an unexpected event and requires prompt action in order to avoid or reduce any adverse consequences to public health (refer to ICRP Pub. 103, 5.2).

[49] An "existing exposure situation" is described as a situation where exposure already exists at a higher level than usual and a decision on the need for control needs to be taken, including risking long-term exposure to residual radioactive material from a nuclear or radiological emergency after the emergency exposure situation has been declared to be over. Exposure to residual radioactive material from a nuclear reactor accident is cited as an example (Pub. 103, 6.3).

[50] A "reference level"is as follows: In emergency or existing controllerable exposure situations, this represents the level of dose or risk, above which it is judged to be inappropriate to plan to allow exposure to occure (e.g., implementation of evacuation zones), and below which optimaization of protection should be implemented (Pub. 103, 5.9.2.).

[51] The ICRP recommendation issued in 1990 (Pub. 60, 6.3.2) states that it should be below 500mSv (5,000mSv for skin). The ICRP recommendation issued in 2007 states that "below 1,000mSv" should be one option.

[52] ICRP publication 63, which preceded the ICRP 2007 recommendations , states that, in terms of public exposure in an emergency, (i) if a exposure dose more than 50mSv is avoidable in a temporary stay-indoors evacuation, (ii) if aexposure dose more than500mSv is avoidable in a temporary stay-indoors evacuation (within a week), (iii) if a exposure dose more than 1,000mSv is avoidable in an permanent relocation (over a week), (iv) if 500mSv of thyroid exposure is avoidable through the distribution of stable iodine, then these actions shall be nearly always justified. However, if only less than one-tenth of the exposure dose (relocation in (iii) should be less than 100mSv/month of the exposure dose) is avoidable, then they shall not be always optimized. In terms of food, if the dose rate more than 10mSv/year is avoidable in the prescribed action, then that action should nearly always be justified.

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Additionally, the ICRP provides a recommendation that in an "existing exposure situation," reference levels should be established within the range of 1mSv to 20mSv per year depending on the situation (Pub. 103, 6.5).

Additionally, a normal situation that does not fall under "radiation emergency situations" or "existing exposure situations" shall come under "planned exposure situations." An exposure limit in the case of public exposure[53] is 1mSv/year.

Radiation exposure is classified into two kinds: "external exposure" and "internal exposure." External exposure occurs when the body is exposed to radiatoion from the radioactive source outside the body. Internal exposure occurs when the body is exposed to radiation from the radioactive source inside the body. In the Life Span Study described above, the exposure dose received by individuals was estimated based on a radiation dose of direct irradiation from the exploding atomic bomb, in other words, the primary external exposure, derived from a relationship between the distance between the point where each individual affected by radiation exposure and the center of the explosion, with or without shelters, and the characteristic of the atomic bomb dropped. Hence, neither the secondary external exposure from radioactive fallout from the explosion nor the internal exposure that each individual received from the radioactive fallout were taken into consideration. Thus, if the radiation exposure (the secondary external exposure and internal exposure) that each individual actually would have been affected by was taken into consideration, the actual exposure radiation dose may have actually been higher than the estimated exposure dose. Thus, it is likely that the cancer rates that were based on the data from the Life Span Study were overestimated against the estimated exposure dose.

External exposure occurs when the radioactive source is outside the body while internal exposure occurs continuously until the radioactive source decays out through radioactive disintegration or it is excreted from the body When radioactive material is taken in and remains in a specific part of the body, the surrounding cells of the radioactive material are intensively exposed to radiation[54] (Pub. 103, 4.3.2). This does not occur in external

[53] An "exposure limit" is an amount that an individual would not be allowed to receive in a planned exposure situation.

[54] In the current nuclear accident, most of the radioactive material was released as gas. Thus it seems that there is no need to take into consideration the effect of radioactive materials ingested by the organism as solid matter.

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exposure[55]. The ICRP recommends that internal exposure should also be evaluated based on the a predicted dose (committed dose) which is expected to receive over a period of 50 years (for a minor, until he or she is 70 years old) from the time that the radioactive material is taken into the body As described above, the effect of internal exposure cannot be clearly defined using the epidemiological data in the Life Span Study. Various studies are currently being conducted, but the mechanism of how internal exposure affects an organism has not yet been clarified using factual data.

c. Standards in Japan

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

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

This NE Guideline formulated the "indices of stay-indoors evacuation and evacuation". A stay-indoors evacuation should be conducted if a predicted effective dose from external exposure (predicted exposure to radioactive material or radiation while outdoors during a period of radiation discharge) is 10 to 50mSv, and evacuation (or a stay-indoors evacuation into concrete buildings) should be carried out if the external radiation dose is more than 50mSv.

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

In addition, with regards to food, the NERHQ formulated the "Index for restrictions on the intake of food and beverages" in the table below as a guideline for discussions on whether or not it is necessary to take measures to restrict food and beverages[56].

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[55] The ICRP also points out that the evaluation of internal exposure is much more difficult than that of external exposure (Pub. 103, 4.5).

[56] The "Index for restrictions on the intake of food and beverages" sets two criteria: (i) 50mSv/year of thyroid gland equivalent dose for radioactive iodine, and (ii) 5mSv/year of effective dosefor radioactive cesium. Index

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Table V-1 Index for restrictions on the intake of food and beverages

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

Uni TBq/kg

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

Next, concerning workers engaged in radiation work in radiation controlled areas (hereinafter referred to as "radiation workers"), Japan has formulated "Ionization Radiation Injury Prevention Rules" (hereinafter referred to as "Ionization Rules"), "Rules for Commercial Nuclear Power Reactors concerning Installation, Operation, etc." (hereinafter referred to as "Commercial Reactor Rules"), "Notice on Exposure Limits Based on Provisions of Commercial Power Reactor" (hereinafter referred to as "Commercial Reactor Notice"), and "National Personnel Authority Rules 10-5 (Prevention of Radiation Injuries in Staff)", which states that the radiation exposure dose (hereinafter referred to as "Dose Limit") of radiation workers should be less than or equal to 100mSv/5 years and less than or equal to 50mSv/year[57] based on ICRP recommendations. In this regard,

values in the Table V-1 are set for, neither of which to exceed the criteria.

[57] Article 4, Paragraph (1) of Ionization Rules; Article 9, Paragraph (1) of Commercial Reactor Rules; Article 6, Paragraph (1) of Commercial Reactor Notice; and Article 4, Paragraph (1) of National Personnel Authority Rules 10-5.

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however, it is stipulated that, in emergency situations[58], the exposure limit shall be 100mSv, in Article 7, Paragraph 2 of Ionization Rules; Article 9, Paragraph 2 of Commercial Reactor Rules; Article 8 of Commercial Reactor Notice; and Article 4, Paragraph 3 of National Personnel Authority Rules 10-5.

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

a. Raising the exposure limit to 250mSv

TEPCO executives, who had been staying at the Prime Minister's Office since the accident at the Fukushima Dai-ichi NPS, were informed by corporate headquarters that radiation levels at the site were rising. The TEPCO executives recognized that it might be impossible to continue operations to manage the nuclear accident if they insisted on the current legal exposure limit and asked the NSC and NISA for their advice. In response to this request, at the Prime Minister's Office in the afternoon of March 14, it was decided that the exposure limit for emergency operations should be increased from 100mSv to 250mSv. At that time, consideration was given to the fact that ICRP Pub. 103 stipulates that the exposure limit for emergency workers should be 500mSv to 1,000mSv, 250mSv[59] is half the lower limit, and the "Regulatory Guide for Reviewing Nuclear Reactor Site Evaluation and Application Criteria" developed by the Japan Atomic Energy Commission in 1964 describes that the exposure to be temporarily allowed based on the recommendations of the guide is 250mSv.

In response to this implementation, on the same day, the Ministry of Health, Labor and Welfare and METI worked together to prepare a ministry order and a notice to the effect

[58] These rules define situations of "emergency operation" as: "those where a disaster occurs or is likely to occur, where urgently necessary action should be taken to handle the damage to nuclear power reactor facilities that might otherwise seriously disrupt the operation of a nuclear reactor" (Commercial Reactor Rules); "those where an accident that is relevant to the provisions of Article 42, Paragraph (1) occurs and emergency operation is required to prevent health problems in workers from radiation in zones relevant to said paragraph" (Ionization Rules); and "those where an accident that is relevant to provisions of Article 20, Paragraph (1) occurs,and emergency operation is required to prevent problems from radiation" (National Personnel Authority Rules 10-5).

[59] Pub. 103 has not yet been incorporated into Japanese law. The Radiation Council Basic Committee, however, implemented a "Second Interim Report on the Introduction of the 2007 Recommendations (Pub. 103) of the International Commission on Radiological Protection (ICRP) into Domestic Systems" in January 2011, stating that the exposure limit in an emergency in Japan should be brought into line with the recommended value that is internationally accepted.

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that from the date when a nuclear emergency is declared to the date when the nuclear emergency is lifted in a zone where emergency countermeasures must be taken the exposure limit should, in unavoidable circumstances, be 250mSv[60]. Sometime after midnight the same day, they asked MEXT Radiation Council[61] for advice. The Council debate the proposed exposure limit by email throughout the day until just before dawn the following day and replied that it was reasonable. In response to this advice, the Ministry of Health, Labor and Welfare and METI formulated a ministry order[62] and a notice to that effect, dated April 14 and the ministry order and notice were issued (published in an official gazette) on March 15.

b. Discussion on raising the exposure limit to 500mSv

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

c. Lowering the exposure limit to 100mSv

On August 30, the Ministry of Health, Labor and Welfare started discussing lowering the exposure limit for emergency operations back to 100mSv. The Ministry, under mutual

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60 The Ministyr of Health, Labor and Welfare received a report to that effect from a Labor Standards Bureau officer. The Ministry, under the Minister's direction, advised the Prime Minister's Office stating that the prescribed exposure limit should not be raised immediately to 250mSv, but rather to 200mSv. And, finally, at the government affairs level, it was discussed and decided that the exposure limit should be raised to 250mSv.

61 The Radiation Council discussed this subject in an advisory meeting. They reached a consensus based on the "Second Interim Report and replied that the exposure limit suggested in the ministry order and notice was reasonable. Additionally, the discussion continued until 03:00 the following day, but the date of the reply was, as per both Ministries' intention, posted as March 14, which is when the participants started their discussion by email.

62 The "ministry order on the special rules of Ordinance on the Prevention of Ionizing Radiation Hazards for responding to events resulting from the 2011 Tohoku District-off the Pacific Ocean Earthquake" and "the notice on exposure limits based on the Rules for Commercial Nuclear Power Reactors concerning Installation and Operation" were exclusively for the unavoidable urgent activities necessary for responding to events resulting from the 2011 Tohoku District-off the Pacific Ocean Earthquake.

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arrangement with TEPCO, METI, and other organizations, excluding staff who had already been involved in this arrangement before the exposure limit was raised, started to implement a ministry order[63] where the phrase "in unavoidable circumstances" should be changed to "in unavoidable circumstances and in circumstances the Minister of Health, Labor and Welfare deems unavoidable" for the "ministry order on the special rules of Ordinance on the Prevention of Ionizing Radiation Hazards to respond to the events resulted from the 2011 Tohoku District-off the Coast of Pacific Ocean Earthquake", and asked the Council of Labor Policy for advice on October 24[64]. The Council replied that it was reasonable. The ministry order became effective as of November 1.

(3) Organizational framework for radiation control at TEPCO

a. Organizational framework for radiation control before the nuclear accident

(a) Organizational framework for radiation control before the nuclear accident

The Ionization Rules define a controlled area as an area where the level of radiation may reach beyond a specified amount (Article 3)[65]. The Rules stipulate that concerning nuclear power station operators who are involved in radiation work: (i) the designated area shall be clearly marked with a sign that shows access to the area is restricted to those individuals who require access in order to perform their duties (Article 3), (ii) radiation workers shall not be exposed to more than a specified radiation exposure dose (Article 4 to 6), (iii) radiation workers shall be equipped with measuring instruments designed to measure exposure dose (Article 8), and (iv) radiation workers shall be educated about the effects of ionizing radiation on organisms (Article 52 (7) and agree to undergoing a physical examination (Article 56). In addition, as an agreement among

[63] The Ministry order revised, as per a ministry order, "the special rules of Ordinance on the Prevention of Ionizing Radiation Hazards for responding to events resulting from the 2011 Tohoku District-off the Pacific Ocean Earthquake."

[64] The "ministry order on the special rules of Ordinance on the Prevention of Ionizing Radiation Hazards to respond to events resulting from the 2011 Tohoku District-off the Pacific Ocean Earthquake" was originally a temporary special ministry order. Hence, the Ministry of Health, Labor and Welfare did not bother asking the Radiation Council for advice.

[65] Article 3, Paragraph (1) of Ionization Rules defines a "controlled area" as an area where the total of effective dose from external radiation and effective dose from radioactive material in the air may reach more than 1.3mSv every 3 months, and where the surface density of radioactive material may reach more than one tenth of the limit value designated in table 3 of the Rules.

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operators who are involved in nuclear operations, which is not a statutory regulation, TEPCO shall have radiation workers registered as professional radiation operators with a radiation worker certificate provided by the Central Registration Center of Radiation Workers located at the Radiation Effects Association.

(b) Control of radiation radiation doses

TEPCO controlled exposure doses based on in-house manuals including the "Radiation Field Control Manual" in order to protect its radiation workers from radiation exposure as follows: a TEPCO radiation worker was supposed to equip themselves with a rental alarm pocket dosimeter (APD) in the access control zone of the controlled area before they entered that controlled area to perform their duties. The external exposure dose that individual radiation workers received was measured with an APD and combined with data, which included the individual's name, hours worked and duties, using a mechanical control to measure the exposure. In addition, TEPCO nuclear power station staff were supposed to be tested to measure the level of internal exposure using a whole body counter (WBC) once every three months.

TEPCO partner companies, too, were expected to follow a similar exposure control program for their staff in the same way TEPCO did for its staff.

b. Organizational framework for radiation control after the nuclear accident

(a) Establishment of temporary and emergency radiation controlled zones

After the nuclear accident at the Fukushima Dai-ichi NPS, radiation levels increased throughout the entire premises of the nuclear power station. However, TEPCO was not initially willing to redefine a controlled area as stipulated in its in-house safety regulations[66]. On April 27, however, as described in Section c(b) below, based on the fact that a female radiation worker received radiation exposure greater than the allowed exposure limit, NISA instructed TEPCO to validate its organizational framework for radiation control and implement measures to rectify this situation. In response to this, on

[66] This is expected to be determined by a licensee of reactor operations based on Article 37, Paragraph (1) of the Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors.

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May 2, TEPCO designated the entire premises of the Fukushima Dai-ichi NPS as a temporary and emergency radiation controlled zone to be controlled in the same manner as a radiation controlled zone. It was decided that the controlled zone should be treated as a controlled zone stating that it would be marked with a sign showing that access to the designated area is restricted to those individuals who require access in order to perform their duties, other necessary signs would be installed, and that radiation workers must be equipped with a rental APD and other protective equipment[67].

(b) Registration as a radiation worker

At the Fukushima Dai-ichi NPS, from the date of the nuclear accident through to May 10, radiation workers were allowed to carry out their duties inside the temporary and emergency radiation controlled zone after receiving a brief 30-minute explanation about how to protect themselves from radiation and how to wear protective equipment. In addition, (although there is no legal obligation to do this) there was a delay in radiation workers getting registered as professional radiation workers with a radiation worker certificate provided by the Central Registration Center of Radiation Workers and so some radiation workers performed their duties without a radiation worker certificate.

(c) APD (alarm pocket dosimeter)

TEPCO had about 5,000 APDs installed at the entrance to the controlled zone of Units 1 to 6 and at the entrance to the centralized waste treatment facilities in Units 1 to 6, but most of them were covered in water and damaged by the tsunami. Hence, as a temporary arrangement, it was decided to perform radiation control measures using about 320 APDs that had been kept in a Seismic Isolation Building. Sometime between March 12 and 13, 500 APDs (200 of them from the Fukushima Dai-ni NPS) were

[67] TEPCO designated the entire premises of the Fukushima Dai-ichi NPS as a temporary and emergency radiation controlled zone, but no signs have been installed to indicate this. Additionally, the following measures were taken inside the Seismic Isolation Building: from March 12, air dose rates were measured; from March 24, the concentration of radioactive material in the air was measured; on March 26, an air vetilator was installed; on March 27, radiation lead shields were placed on windows; and between April 1 and 8, floor mats were replaced. Because of these measures, from April 4, the concentration of radioactive material in the air of the Seismic Isolation Building fell below regulation limits (Ionization Rules and Commercial Reactor Rules). It was then decided to treat the inside of the Seismic Isolation Building as an uncontaminated area.

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provided as aid supplies from Kashiwazaki Kariwa Nuclear Power Station. Unfortunately, however, there was a lack of communication between the pickup window personnel that received the APDs and the health physics team that desperately needed them, and these APDs were simply stored, unused until April 1. Many workers left the Fukushima Dai-ichi NPS after the earthquake and initially very few remained to perform their duties. Gradually more and more joined them until there were not enough APDs and by March 15 not every worker was able to wear an APD. In response to this situation, Mr. Masao Yoshida, head of the Fukushima Dai-ichi NPS (hereinafter referred to as "site superintendent Yoshida") decided to let only the leaders of an operational group wear APDs on behalf of the entire group as long as the following conditions were met: (i) the assumed total radiation doseradiation dose per job is not great (less than about 10mSv), (ii) air radiation dose rates at the worksite are known, (iii) environmental dose rates gradient (difference between air radiation level rates in the same space) is not great, and (iv) all members of an operational group always together at a worksite. This decision was made based on the following assessment: the provisory clause, which states that "however, if it is considerably difficult to perform the said measurement with the said radiation measuring instrument, the said dose from external exposure may be computed using the dose equivalent, and if it is also considerably difficult to compute it, then the said value may be obtained through calculations," of Article 8, Paragraph 3 of Ionization Rules stipulating that "the measurement of radiation dose from external exposure according to Article 1 shall be performed by wearing radiation measuring instrument on parts of the body specified in the following items", was applicable to this case. As described above, a sufficient number of APDs was finally obtained on April 1. TEPCO decided to have all of its workers wear APDs from the same day and to not allow them to work if there were not enough APDs.

(d) Managing access to and from a controlled area

After the nuclear accident, access to and from the controlled area of the management system was initially rendered inoperative for calculating the exposure doseradiation dose of individual radiation workers. TEPCO decided to manually calculate the

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radiation dose radiation dose of individual radiation workers using APDs. On April 14, TEPCO had five simplified instruments installed in the Seismic Isolation Building for gaining access to and from the controlled area management system. At the same time, they introduced a radiation work permit with bar code patterns so that the names and radiation doseradiation dose of individual workers could be automatically recorded[68].

c. Occurrence of exposed subjects and their countermeasures

(a) Subjects exposed to contaminated water from the Unit 3 turbine building

On March 24, three workers from a TEPCO partner company (male staff member A in his 30s, male staff member B in his 20s, and male staff member C in his 30s), who were installing electric cables under the surface of the basement floor of the Unit 3 turbine building, were exposed to high radiation dose while working immersed in contaminated water. In terms of radiation doseradiation dose (external exposure), staff member A received 180.1mSv, staff member B received 179.34mSv and staff member C received 173mSv before they had finished working[69].

On March 24, these three staff members were informed that the air radiation dose rate at the worksite in the basement of the Unit 3 turbine building was about 2mSv/h on the previous day, March 23, before they walked down to their worksite. They put on Tyvek protective suits and charcoal filter masks and also carried an APD with them. Additionally, staff members A and B put on low quarter shoes and staff member C wore high boots. Then they headed for the worksite. Their APD was set to sound an alarm once each time the external radiation doseradiation dose reached 4mSv and to sound a continuous alarm for three minutes to alert them that the external doseradiation dose had reached 20mSv.

The three staff members found that there was a pool of water about 15cm deep

[68] From March 17, radiation workers who did not go through the Seismic Isolation Building were expected to attach ADPs at J village and to record the day's levels when returning the ADPs upon finishing work for the day. J village had APDs from more than one manufacturer. Hence, the Acces Control Devices were implemented on June 8.

[69] These three staff members, A, B, and C, were tested to measure their internal radiation doses following the incident. In terms of internal radiation doses, staff member A received 39mSv, staff member B received 35mSv and staff member C received 0mSv.

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covering the entire floor. They thought that it was probably only seawater and decided to start working. Their APD sounded before they started working. However, they thought that either their APD had sounded to tell them that its battery was flat[70] or that their APD had malfunctioned due to the following reasons: they had been informed in advance that the air radiation dose rate at the worksite was about 2mSv/h, and they had heard alarms before indicating an APD malfunction or as an alert to charge a flat APD battery. Thus they proceeded with installing the electric cables. Later staff member A heard the APD sound continuously and wondered if the air radiation dose at the worksite could be higher than expected. However, he thought it was important for them to complete their job to restore the power supply so they continued working.

After completing their job, it was discovered that these three staff members were all likely to have received high radiation dose. Staff members A and B in particular were at a high risk of radiation heat burns from their feet being soaked in radioactive water because they were wearing low quarter shoes thus subjecting them to continuous localized exposure. They visited Fukushima Medical University Hospital and the National Institute of Radiological Sciences to get cleaned up and have a checkup and get tested to measure their internal radiation doses. The localized radiation dose both staff members A and B received on their feet was 466mSv. Neither staff member A nor B suffered radiation heat burns on their feet.

In response to this incident, on March 25, TEPCO and its partner companies decided that if workers find something at their worksites contrary to what they are told in advance, they should report to the Station ERC to seek directions and that workers should leave their worksites immediately if they hear an APD sound its alarm. They gave their workers instructions to this effect.

(b) Subjects exposed to radiation exceeding the dose limit for female staff (5mSv for three months)

Four whole body counters (WBCs) that had been installed at the Fukushima Dai-ichi

[70] An APD sounds repeatedly when its battery is running low in the same manner as when the external radiation dose has reached the upper limit.

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NPS were rendered inoperative due to a power blackout and an increase in air radiation dose rate. On March 22, TEPCO borrowed vehicle-mounted WBCs from JAEA and had them installed at Onahama. TEPCO started measuring the internal radiation dose of individual workers who were engaged in emergency work at the Fukushima Dai-ichi NPS using these WBCs. As a result, on April 27 and May 1, it was discovered that two female staff had received radiation dose exceeding the dose limit[71] for women that is 5mSv for three months.

Female worker D, in her 50s, who was exposed to 17.55mSv of radiation, had mainly been engaged in firefighting related jobs at the fire station gatehouse near the Seismic Isolation Building excluding the period from March 11 to 23 when she had been temporarily evacuated to the Fukushima Dai-ni NPS. While she was working there, she refueled fire engines more than once outside the Seismic Isolation Building. Female worker D had been working at the gatehouse until she received the instruction of evacuation issued from the Fukushima Dai-ichi NPS on March 23.

Female staff member E, in her 40s, was exposed to 7.49mSv of radiation while she had been engaged in healthcare-related work as a crisis team member in the Seismic Isolation Building during the period from March 11 to 15. In the Seismic Isolation Building, she usually stayed in the emergency response control room on the second floor. Whenever someone was injured or sick, she went to the sickbay located near the entrance on the first floor to take care of him or her. She also worked near the entrance of the Seismic Isolation Building whenever emergency personnel arrived from outside. The doors of the entrance to the Seismic Isolation Building, which were bent and twisted at the time, were only temporarily sealed up. Hence, the air radiation dose rate on the first floor was higher than that on the second floor. In addition, female staff member E has not returned to the Fukushima Dai-ichi NPS since leaving there on March 15.

A common factor in both female staff members D and E, who were exposed to radiation, was that both of them had spent a long period of time near the entrance of the first floor of the Seismic Isolation Building, where the air radiation dose rate had been

[71] Article 4, Paragraph (2) of Ionization Rules, Article 6, Paragraph (1), Item (3) of Commercial Reactor Notice.

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relatively high since the day of the nuclear accident. One factor specific to female staff member D was that she was engaged in refueling operations several times outside the Seismic Isolation Building.

On May 2, TEPCO summarized the causes of these radiation exposure incidents in which its staff received radiation dose beyond allowable dose limits and established measures to prevent similar incidents in the future and reported their findings to NISA. This report describes the causes of these incidents as follows: after the nuclear accident, access to and from the Seismic Isolation Building was not properly controlled initially, the double-entry doors to the Seismic Isolation Building were not airtight and the doors to the Seismic Isolation Building were bent and twisted by the hydrogen explosions in Units 1 and 3. TEPCO concluded that these factors resulted in female staff members D and E inhaling radioactive materials. Based on this conclusion, TEPCO implemented measures to prevent similar incidents in the future as follows: (i) on and after March 23, the Fukushima Dai-ichi NPS shall be managed and controlled without female workers, and (ii) the concentration of radioactive materials in the air shall be reduced in the Seismic Isolation Building by installing a local ventilation machine. In addition, TEPCO decided to implement the following additional measures for the future: (i) the entire premises of the Fukushima Dai-ichi NPS shall be treated as a controlled zone, (ii) radiation workers shall wear proper protective equipment to match their working environments, (iii) a system shall be implemented to control exposure, (iv) internal exposure doses for individual workers shall be measured more often (once a month when incidents have occurred and once every three months during normal times), (v) individual radiation workers shall be tested to measure internal radiation doseradiation dose if the external radiation dose they have received exceeds 100mSv, and (vi) they shall not be allowed to work at the Fukushima Dai-ichi NPS if the external radiation doseradiation dose they have received exceeds 200mSv. TEPCO reported these findings to NISA.

(c) Subjects exposed to radiation exceeding the dose limit for urgent emergency work (250mSv)

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Subsequently, it was discovered that, on June 10 two workers (male staff member F in his 30s and male staff member G in his 40s), on June 20 1 worker (male staff member H in his 50s), and on July 7 three workers (male staff members I, J, and K in their 20s) had been exposed to radiation over 250mSv of the radiation dose limit, which was newly mandated by law.

Male staff members F, G, and H kept watch in the main control room of Units 3 and 4 during the period from March 11 to the evening of March 13 and subsequently they were engaged in their work several times. The exposure dose that these three staff members received were as follows: staff member F received 678.08mSv (88.08mSv of external dose and 590mSv of internal dose), G received 643.07mSv (103.07mSv of external dose and 540mSv of internal dose) and H received 352.08mSv (110.27mSv of external dose and 241.81mSv of internal dose).

Staff members F and G were engaged in collecting plant data in the main control room. Staff member H was the leader of additional staff in the same room. After the earthquake, the air radiation dose rate increased in the main control room of Units 3 and 4. Staff member H instructed the other staff in the room to wear masks. Unfortunately, there were not enough charcoal filter masks, which can screen out volatile iodine, for each staff member in the room. Some staff in the main control room wore charcoal filter masks and others wore dust filter masks, which cannot screen out volatile iodine, until charcoal filter masks were delivered from the Seismic Isolation Building in the evening of March 12. Staff members F, G, and H wore dust filter masks until the charcoal filter masks were delivered from the Seismic Isolation Building in the evening of March 12[72]. In the control room, individual staff members were in charge of specific panels and were engaged in checking their respective panels on a continual basis. Staff members F and G spent most of their time checking the meters nearest the emergency doors, which were bent and twisted by the blast of the explosion[73]. On the evening of March 13, these three staff members were replaced with backup members and then moved to the Seismic

[72] They shared a charcoal filter mask whenever they had to work outside the main control room.

[73] Some other staff members, too, were engaged in checking meters just as staff members F and G were, but they were nowhere near the emergency doors.

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Isolation Building. At dawn on March 15, they were instructed to evacuate to the Fukushima Dai-ni NPS. Subsequently when they moved to the Seismic Isolation Building of the Fukushima Dai-ni NPS, they were grouped into teams to collect data in the same rooms in regular shifts for intervals of several hours[74]. Additionally, staff member F was engaged in vent operations with two other staff members on March 13. Staff member G was engaged in refueling operations with two other staff members near Unit 1 on March 12. Staff member H had not been engaged in any outdoor operations until he moved to the Seismic Isolation Building. From March 14, he was engaged in refueling operations or checking fire extinguishing pumps at his worksite. In addition, these three staff members had not taken stable iodine tablets until they moved to the Seismic Isolation Building on the evening of March 13[75]. Additionally, staff member F had occasionally smoked cigarettes before the explosion in Unit 1 on March 12. Additionally, staff members F and H wore glasses.

Further, three staff members, I, J, and K, had been engaged in both restoring meters to their former state in the main control rooms of Units 1 and 2, and securing electric power supply outdoors, staying mainly in the Seismic Isolation Building since the earthquake. The radiation dose that these three staff members received was as follows: staff member I received 308.93mSv (49.23mSv of external dose and 259.70mSv of internal dose), staff member J received 475.50mSv (42.40mSv of external dose and 433.10mSv of internal dose) and staff member K received 359.29mSv (31.39mSv of external dose and 327.90mSv of internal dose).

Early in the morning of March 12, the main control room shift supervisors of Units 1 and 2 instructed the staff in the rooms to wear masks. Staff member K wore a charcoal filter mask. Staff member J, most likely wore a dust filter mask, at least in the beginning. Staff member I joined the operations in the control room from that same day and from the very beginning wore a charcoal filter mask.

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[74] From March 15, younger staff members were excluded from the teams to collect data in the main control room,. Additionally, staff member G, who had already been found to have received a high external radiation dose at that time, was excluded from working in the main control room.

[75] Staff member F says that, as far as he remembers, he did take stable iodine tablets, but there is no record showing that he did.

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Subsequently, staff members I, J, and K were engaged in restoring meters to their former state in the main control rooms of Units 1 and 2 and in carrying meters to the control rooms wearing Tyvek protective suits and charcoal filter masks.

The emergency doors to and from the main control rooms of Units 1 and 2, which had been bent and twisted by the blast from the explosion in Unit 1, were only temporarily sealed up with vinyl sheets. Meters on the side of Unit 1 were located in a stream of air flowing from the emergency doors. Staff members I, J, and K were also engaged in restoring these meters to their previous state.

Additionally, there were sweets and drinks on the tables in the main control rooms of Units 1 and 2. These three staff members sometimes ate and drank at the table without wearing masks. Moreover, staff members J and K sometimes took their masks off and spent short periods of time without them or they loosened their masks because their breath fogged up their masks or their masks were too tight giving them a headache. Additionally, staff members I and J wore glasses.

A common factor in both staff members F and K receiving radiation exposure was that both of them were engaged in their duties near the emergency doors. Moreover, a common factor in staff members F, G, H, and J receiving radiation exposure was that they wore dust filter masks instead of charcoal filter masks while they were working.

TEPCO summarized the causes of radiation exposure for staff members F and G on June 17 and those of staff members H, I, J, and K on August 12, and reported these findings to NISA. The report describes the suspected causes of radiation exposure as: (i) it was difficult to wear masks properly and implement protective measures to control radiation even more effectively, (ii) its staff had no choice but to eat and drink in the main control room, (iii) the arms of glasses created a gap between the face and the mask, and (iv) its workers were engaged in their duties near the emergency doors, where the concentration of radioactive material was estimated to be extremely high. Based on these estimations, TEPCO decided to implement the following measures to prevent similar radiation exposure in the future: (i) information shall be shared more efficiently and equipment and material including masks shall be placed in their proper location, (ii) staff shall eat and/or drink only in designated areas, (iii) staff shall learn how to use and

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manage protective equipment for personal protection, and (iv) staff shall complete a pre-work survey.

(d) Health care provided for staff engaged in emergency works

TEPCO conducted further evaluations on the internal exposure its staff received. Subsequently, it was discovered that some employees who had been working on the premises of the Fukushima Dai-ichi NPS quit immediately after the nuclear accident and their whereabouts remained unknown. TEPCO collected and compiled this data and reported their findings to NISA. On July 7, NISA performed an on-site inspection to confirm that identification was not conducted properly, not even with public/official identification; that upon issuing a work permit the license was not delivered by hand; and that access to and from the nuclear power station was not managed exactly according to specific rules and regulations prescribed by nuclear power station authorities. On August 1, based on this on-site inspection, NISA reprimanded TEPCO and instructed TEPCO to provide a report summarizing how it would improve its system.

Prior to June 8, access to the Fukushima Dai-ichi NPS was possible even without a work permit. From June 8, access to the station required a work permit. However, a work permit was only issued if a partner company had confirmed the original public/official document with a photo attached. TEPCO issued copies of the work permit. Thus, TEPCO's work permit were handed out on a per partner company basis, not on a per person basis. TEPCO decided that from July 19 work permits should be handed out directly to individual workers on a per person basis.

In addition, TEPCO asked its partner companies to perform aggregate data research. As a result, it was discovered that a total of 150 workers (11 workers in March, 66 workers in April and 73 workers in May), who previously belonged to TEPCO's partner companies and worked on the premises of the nuclear power station, were unable to be contacted. On August 8, TEPCO announced this. Subsequently, TEPCO and its partner companies fully examined all lists of their employees and established their contact details. As a result, as of October 31, only 16 of the 150 workers were unable to be

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contacted. In addition, as of this date, employees who had worked on the premises of the station after July were all contacted.

On May 17, the NERHQ developed a "Policy for Immediate Actions for the Assistance of Nuclear Sufferers" implementing long-term health management and a database capable of tracking the exposure radiation dose over the long-term for all workers engaged in emergency operations to help control the current situation. In response to this situation, on June 27, the MHLW established an "investigative commission for long-term health management of workers at TEPCO's Fukushima Dai-ichi NPS" lead by Mr. Yoshiharu Aizawa, vice-president of Kitasato University School of Medicine. The commission discussed how to conduct long-term health management of employees engaged in emergency work even after they left their current jobs including acquiring necessary information and conducting health checks. On September 26, the commission developed a report and issued an announcement to that effect.

(4) Radiation dose limit for government employees in an emergency

a. Radiation dose limit for government employees in emergency works

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

On the morning of March 16, a staff member of National Personnel Authority in charge of National Personnel Authority Rules learned via a news report that both the MHLW and METI had raised the radiation dose limit for workers engaged in emergency works. With regards to national government employees employeed in regular government service, it is likely that, for example, Nuclear Safety Inspectors might be engaged in emergency worksat a nuclear power station. Hence, a staff member immediately asked MHLW to provide him with the relevant documents. To discuss the matter, the staff member also phoned a Defense Ministry staff member in charge of a "Ministry of Defence official directives concerning staff health care" that is quoted from National Personnel Authority Rules 10-5. At approximately 18:00 on March 16, the same staff member asked

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the MEXT Radiation Council advice on a ministry order revision that the exposure limit should be 250mSv to respond to events resulting from the 2011 Tohoku District-off the Pacific Ocean Earthquake from the date when the nuclear emergency is declared to the date when the nuclear emergency is lifted, in a zone where emergency countermeasures must be taken in unavoidable circumstances.. The Radiation Council had a debate on the proposed dose limit by email from 18:30 to 19:30 that day. They reached a consensus and replied that it was reasonable. In response to this advice, the National Personnel Authority revised part of the Nuclear Disaster Special Measures Law, Article 28 of the National Personnel Authority Rules 10-5, as follows: "In response to events resulting from the 2011 Tohoku District-off the Pacific Ocean Earthquake from the date when the nuclear emergency is declared (pursuant to Paragraph 2 of Article 15 of the Nuclear Disaster Special Measures Law enacted in 1999, No. 156) to the date when the nuclear emergency is lifted (pursuant to "Paragraph 4 of the Article, in a zone where emergency countermeasures must be taken prescribed in Paragraph (8) of Article 17 of the same Law), in unavoidable circumstances the exposure limit "100mSv" (prescribed in Item (3) of the same Paragraph), concerning the application of the provision of Paragraph 3 of Article 4, should be replaced with the dose limit of 250mSv." This revision was published in a government gazette the next day, March 17, and took effect that day.

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

Defense Ministry staf, including Self Defense Force personnels, are government employees for special government service and they are not directly subject to National Personnel Authority Rules[76]. However, Paragraph 2 of Article 26 of "Ministry order on health care management of Defense Ministry staff" stipulates that "the limit of effective dose equivalent for directees (workers under management) who are engaged in emergency worksto prevent radiation hazards shall comply with the rules of staff who are engaged in emergency works (Paragraph 3 of Article 4 of National Personnel Authority Rules 10-5,

[76] Article 2, Paragraph (3), Item (16); Article 2, Paragraph (5); Article 3, Paragraph (2); and Article 16, Paragraph (1) of the National Public Service Act

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Hence, the limit for the effective doseequivalent shall comply with the rules of National Personnel Authority Rules 10-5.

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

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

Provisions of the Industrial Safety and Health Act, rather than those of the National Personnel Authority Rules, are applied to local government employees including police officers and firemen[77]. Hence, the radiation doser limit for local government employees in emergency operations was raised to 250mSv on March 14.

A guideline on the radiation dose limit for police officers and firemen contained in the NE Guideline prepared by the NSC in June, 1980, stipulates that "the upper limit of radiation dose, especially for those who are engaged in emergency works in a nuclear accident site among those engaged in disaster prevention works (for example, staff other than radiation workers employed at the nuclear power station as well as experts dispatched from the national government, those who are employed at police or fire stations, Self-Defense Force personnel, those who are employeded in urgent medical care service), shall be 100mSv in terms of effective dose for emergency works in urgent and unavoidable circumstances to prevent a disaster from worsening and to save lives. Additionally, the "Manual for firefighting activities at nuclear power facilities" prepared by the Fire and Disaster Management Agency in March 2001 stipulates that the "radiation dose limit shall be 100mSv for emergency works to save lives. There were no changes in them.

None of the mobile police officers and firemen engaged in flushing water out into a

[77] Article 58 of the Local Public Service Act.

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spent fuel pool were exposed to radiation dosesexceeding 100mSv.

(5) Radiation exposure of citizens

a. Screening level before the nuclear accident

The "Manual for radiation emergency medical care activities in Fukushima Prefecture," which was created in 2004 fiscal year under the authority of the Fukushima prefectural government, was based on a previous manual "What should be done in radiation emergency medical care and how," which was prepared by the NSC in July 2001 and stipulated that the screening level for residents[78] (a criterion of comprehensive outer body clean up) should be 40Bq/cm^2 [79]. The Fukushima prefectural government, which initially decided that the value was equivalent to 13,000cpm (counts/minute), used 13,000cpm as a criterion for comprehensive entire body clean up.

b. Raising the screening level after the nuclear accident

The NERLHQ at the Off-site Center, which started discussions on screening level settings on March 12, asked the ERC advice on the criterion of 40Bq/cm^2 or 6,000cpm on the morning of March 13. The ERC asked the NSC for feedback and the NSC responded saying that stable iodine should be given to those who experienced radiation dose rates of more than 10,000cpm, further adding that 6,000cpm should be replaced with 10,000cpm[80]. However, this response was not communicated from the ERC to the NERLHQ. Instead, a message submitted to the NERLHQmerely stated that the NERLHQopinion should be

[78] Screening would mean the monitoring service that determines whether or not a monitoring subject has been contaminated by radioactivity and thus needs to be decontaminated. Screening monitoring is conducted by holding radiation dose measurement equipment over the subject being monitored to measure the level to which he or she has been contaminated. The screening level is the level that indicates whether a screening subject needs to be decontaminated if his or her level should exceed the limit.

[79] The value is equal to the value defined as a screening level by the Nuclear Safety Research Association in "Knowledge of radiation emergency medical care" (in March 2003) in radiation measurement for initial exposure medical care. Additionally, a note is attached to this criterion stating that this value is subject to change at any given time that the government decides it needs to be changed.

[80] 10,000cpm is a value that the NSC has decided is equal to 40Bq/cm^2 and is used, as a criterion from a safer side (conservative) point of view.

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respected[81].

At 14:20 on March 13, the head of the NERLHQ issued instructions based on Paragraph 3 of Article 15 of the Act on Special Measures Concerning Nuclear Emergency Preparedness to the heads of Fukushima Prefecture, Okuma-machi, Futaba-machi, Tomioka-machi, Namie-machi, Naraha-machi, Hirono-machi, Katsurao-mura, Minami-soma-shi, Kawauchi-mura and Tamura-shi to the effect that the screening level should temporarily be adjusted to 40Bq/cm^2, or 6,000cpm. The Fukushima prefectural government decided to use the criterion value of 40Bq/cm^2, which was originally a criterion value defined in the "Manual for radiation emergency medical care activities in Fukushima Prefecture" stating that 40Bq/cm^2 was equivalent to 13,000cpm, and started screening based on a screening level of 13,000cpm

On March 13, a team of radiology experts[82] was dispatched to visit the Fukushima prefectural government office to provide radiation emergency medical care. The regional medical division of the Fukushima prefectural government, which was in charge of screening activities, asked the team for advice on how to most effectively conduct screening. The team of experts discussed this amongst themselves and, as a result, decided to implement a special "Fukushima version" screening program for external whole body cleansing for the following reasons: there was not sufficient water due to water supply suspension; the night temperature was below freezing, thus it was risky, especially for sick or ill people, to be decontaminated outdoors; and it was necessary to take care of people swiftly and safely with limited staff. All of these factors made it difficult to conduct screening and standard total external body cleansing. Also, they provided the regional medicine section with advisory instructions. One of the advisory instructions was to raise the screening level to 100,000cpm equivalent to 1μSv/h (an exposure rate at 10cm from body surface)[83], which is prescribed as a screening level for the general public receiving a body surface contamination check in the "Manual for First Responders to a Radiological

[81] The NSC investigated why and how their feedback had not been communicated to the Local Emergency Response Center. As a result, it was discovered that the comment was faxed to the ERC and that it was received by a staff member who had been dispatched from the NSC Secretariat and that no one had seen it since. It still remains a mystery.

[82] Dispatched from Fukui University, Hiroshima University and NIRS.

[83] When measured with the GM Survey Meter "Aloka TGS-136" (5cm window diameter).

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Emergency, 2006 " developed by IAEA. Contrary to instructions from the head of the Local Headquarters, the Fukushima government office accepted this advisory instruction and decided to use 100,000cpm as the screening level for external whole body cleansing. Additionally, Fukushima Medical University Hospital, providing screening services of its own to its patients from March 12, also used 100,000cpm as a screening level due to a lack of water. This fact was also taken into consideration when the Fukushima prefectural government raised the screening level to 100,000cpm.

In the early morning of March 14, having learned via an ERC medical treatment team's report that the Fukushima prefectural government had raised the screening level, the NSC held a discussion on the notion that if the entire 13,000cpm should be from iodine resulting in internal exposure, whether it might be equal to an equivalent dose of 100mSv[84], which is the criterion of stable iodine administration. At 04:30 the same day, the NSC provided the ERC with advice to the effect that "screening criterion should not be raised to 100,000cpm, but instead remain at the current value of 13,000cpm". However, the Fukushima prefectural government continued to use 100,000cpm for its screening service.

Subsequently, the NSC held further discussions based on opinions from municipalities that were engaged in providing screening services at their local sites and at 14:40 on March 19, provided the ERC with the revised piece of advice "regarding screening criterion of radiation emergency medical care," which stated that screening criterion should be raised to 100,000cpm.

c. Implementation of screening

"What should be done in radiation emergency medical care and how" stipultes that relevant local governments, under mutual cooperation with their partner organizations, are specifying places where to conduct rescue and evacuation operations as well as planning to conduct screening services , if necessary. In response to this situation, the "Manual for radiation emergency medical care activities in Fukushima Prefecture" stipulates that a medical treatment team shall be established, which will be led by the divisional councilor

[84] This assumption stands on a safer side (conservative) point of view, although much of the actual contamination appears on the outer surface of clothes and other wearable items.

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of the hygiene services division of the department of health and welfare services in the Nuclear Emergency Response Center and that a screening team shall be established and will consist of health and welfare service staff, core-city healthcare center staff, doctors from the prefectural hospital and the medical association, and radiology technicians from the Fukushima Regional Association of Radiological Technologists, which will conduct body-surface contamination monitoring with survey meters to determine if monitored individuals or subjects need decontamination.

In response to the declaration of a nuclear emergency state by the Japanese government on the night of March 11, the Fukushima prefectural government decided to implement screening services and started doing so the next day, on March 12. However, there were far more monitoring subjects than expected so there were not enough staff members from within the prefecture to allow them to adequately handle all screening services[85]. The Fukushima prefectural government asked the national government, local governments, universities and the Federation of Electric Power Companies for their cooperation in conducting screening services at evacuation facilities and permanent facilities designed for community use. More than a total of 200,000 monitoring subjects representing over 10% of the prefectural population received screening services. The count rate of those monitoring subjects was between 13,000 and 100,000cpm. The number of subjects who needed partial external cleansing was 901, and the number of subects whose measured count rates was higher than 100,000cpm and needed whole body cleansing was 102. However, the count rates of those monitoring subjects whose measured exposure was higher than 100,000cpm was below the designated level when they removed their clothing.

d. Medical checks conducted for the citizens of Fukushima Prefecture

On May 19, the Fukushima prefectural government established the Fukushima Prefecture Health Monitoring Survey Research Committee to discuss how to conduct medical checks for the citizens of Fukushima Prefecture. In response to those committee

[85] The maximum number of facilities used for screening services was 42 on March 19 (including 30 evacuation facilities and twelve permanent facilities meant for community use).

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discussions, on June 30, the Fukushima prefectural government began delivering sets of inquiry forms, which dealt mainly with dietary and behavioral records from March 11, to individual evacuees from Namie-machi, Iitate-mura and Yamakiya district of Kawamata-machi, who were subjects participating in the survey. The same set of inquiry forms was delivered to all remaining citizens of the prefecture on and after August 26. The survey included forms for entering basic survey details as well as medical checkup, Q&A survey, and thyroid gland examination results. The results of the survey are to be managed and maintained in a database on a long-term basis.

e. Distribution of stable iodine

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

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

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

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NERLHQ, who should convey this information to the governors of local governments, and finally that the governors of local governments should then provide this information to their residents[86].

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

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

On the night of March 14, the ERC medical treatment team was informed that the evacuation of hospitalized patients within a 20km radius had not yet been completed and they provided this information to the NSC. In response, a few hours later at 3:10 on March 15, the NSC provided the ERC advice to the effect that the hospitalized patients should have taken stable iodine tablets when they were evacuated according to a provision concerning "Rules on the intake of stable iodine tablets in the evacuation of hospitalized patients from an evacuation zone (within a 20km radius)." The ERC sent this advice to the NERLHQ by fax. However, that same day, the NERLHQ was busy relocating to the Fukushima Prefectural Office building. It was not until later that evening, after they had completed their move, that they discovered the fax conveying this advice. The NERLHQ, which considered it highly likely that in addition to hospitalized patients many elderly citizens living in local communities and hospital staff still remained, created an instruction

[86] The manual for radiation emergency medical care activities in Fukushima Prefecture stipulates that the intake of stable iodine tablets should be communicated by the leader of the Local Emergency Response Center to the leader of prefectural local headquarters, to the leaders of medical treatment teams of prefectural local headquarters, and finally to the leaders of the respective municipalities.

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draft to the effect that subjects who should take stable iodine should include residents other than hospitalized patients. That night, the NERLHQ provided the ERC with its instruction draft stating that residents who should take stable iodine tablets should include all citizens that still remained within a 20km radius. In response to this, the ERC asked the NSC for advice on this instruction draft. At 01:25 on March 16, the NSC distributed advice to the ERC to the effect that all of those who remained within a 20km radius should take stable iodine tablets while being evacuated according to the "Rules on having those who remain in evacuation zones (within a 20km radius) take stable iodine tablets when being evacuated." The NERLHQ, which confirmed this advice via the ERC, issued a written order at 10:35 the same day to the leaders of the Fukushima prefectural government and 12 affected municipalities to "have those who are evacuated from evacuation zones (within a 20km radius) take stable iodine tablets." However, the Fukushima prefectural government did not follow this instruction on the intake of stable iodine tablets because the government had already confirmed that there were no subjects who remained within a 20km radius.

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

Moreover, the Fukushima prefectural government stored and maintained 68,000 stable iodine tablets in the Environmental Medical Research Institute located in Okuma-machi

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for tourists and other visitors to the prefecture. The local Government also asked the ERC and other organizations to help secure stable iodine tablets and were able to obtain approximately 1,360,000 stable iodine tablets from a major stable iodine manufacturer and from the Ibaraki prefectural government.

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

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

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demand.

(6) Damage to radiation emergency medical facilities radiation emergency

"What should be done in radiation emergency medical care and how" (refer to Section (5) a above) states it is critical that an radiation emergency medical care service system shall be implemented with integrated and organized operations and with mutual complementary roles of the following medical facilities to provide effective and efficient radiation exposure medical care: "medical facilities for primary radiation emergency medical treatment" to provide initial medical care and emergency treatment, "medical facilities for secondary radiation emergency medical treatment" to provide professional treatment, and "medical facilities for tertiary radiation emergency medical treatment" to provide highly specialized treatment. In the manual for radiation emergency medical care activities in Fukushima Prefecture, the Fukushima prefectural government has designated the following five locations as medical facilities for primary radiation emergency treatment: (i) Fukushima Prefectural Ono Hospital in Okuma-machi, Futaba-gun; (ii) Fukushima Prefecture Agricultural Cooperatives Futaba Welfare Hospital in Futaba-machi, Futaba-gun; (iii) Imamura Hospital in Tomioka-machi, Futaba-gun; (iv) Fukushima Rosai Hospital in Iwaki-shi; and (v) Minami-soma City General Hospital in Minami-soma-shi; and one location, as a medical facility for secondary radiation emergency medical treatment: Fukushima Medical University Hospital in Fukushima-shi[87].

Three of the five medical facilities designated for primary radiation emergency medical treatment in Fukushima prefecture, Ono Hospital, Futaba Welfare Hospital, and Imamura Hospital, are located in Futaba-gun within a 10km radius of the Fukushima Dai-ichi NPS. These three hospitals were all exposed to large amounts of of radioactive materials discharged from the Fukushima Dai-ichi NPS. According to an order issued by the head of the NERHQ at 05:44 on March 12, each of the three hospitals was in an evacuation zone,

[87] "What should be done in radiation emergency medical care and how" states that medical facilities for primary radiation emergency treatment should be located "near nuclear facilities", and medical facilities for secondary radiation emergency treatment should be at a location "where patients or individuals exposed to radiation can be transferred from nuclear facilities or medical facilities for primary radiation emergency treatment in a proper manner and in a relatively short time." Additionally, MEXT has designated NIRS, in Chiba-shi, as a medical facility for tertiary radiation emergency treatment for the eastern Japan block.

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which prevented the hospitals from functioning as medical facilities for primary radiation emergency medical treatment. The other two medical facilities for primary radiation emergency medical treatment are located in Iwaki-shi and Minami-soma-shi. Minami-soma City General Hospital located in Minami-soma-shi was located in what became a deliberate evacuation zone on April 22.

Additionally, as described above, pre-designated medical facilities for radiation emergency medical treatment and other medical organizations were not able to function at full capacity. Some of those who were injured at the Fukushima Dai-ichi NPS did not have their injuries treated for three days. For example, a TEPCO staff member, who was near the reactor building of Unit 1, suffered a broken left arm during an explosion on March 12 and required an operation. He was initially transported in a TEPCO business vehicle to Ono Hospital, which had been designated as a medical facility for primary radiation emergency medical treatment. As per the description above, the hospital, which was in a deliberate evacuation zone, had already transferred all hospital functions to another location. After being transferred to another hospital he was denied the operation due to a lack of water. To make matters worse, he was separated from TEPCO staff who had been assisting him and thus was left alone without any money. Subsequently, this staff member was moved from one evacuation facility to another. En route to another evacuation facility, he was told that his clothes had been contaminated with radioactivity. Finally he had to surrender his contaminated clothes. It was at yet another evacuation facility that he was able to be supplied extra clothes to wear. Lists of evacuees helped this staff member learn of his family's whereabouts and he was finally able to get in touch with them. On March 14, he flew from Fukushima to Tokyo after his family reserved a flight for him. The next day, March 15, he visited NIRS to have radiation testing. Subsequently, he was able to have an operation on his left arm at a hospital in Tokyo.

5. Contamination of agricultural, livestock, marine products, the air, soil and water

(1) Contamination of water, beverages and food, and the response taken

a. Criteria on the restriction of shipment (before the nuclear accident)

Prior to the nuclear accident there was no criteria by which food and beverages

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contaminated with radioactive material was directly restricted. The only criteria on food and beverages contaminated with radioactive material was the Index[88] for restrictions on the intake of food and beverages indicated[89] by the NSC (refer to Section 4 (1) c above). The index is a guideline for discussions on whether or not it is necessary to take measures to restrict food and beverages, but does not provide criteria for taking measures to restrict their shipment.

This index provides a guideline for each of the following five food categories: (i) drinking water, (ii) milk and dairy products, (iii) vegetables, (iv) grains, and (v) meat, eggs, fish, and other; in terms of: (i) radioactive cesium, (ii) uranium, and (iii) plutonium and three alpha-isotopes of transuranium elements; but ony provides a guideline for radioactive iodine for the following three food categories: (i) drinking water, (ii) milk and dairy products, and (iii) vegetables (excluding root vegetables and tubers)[90].

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

The Radiation Monitoring Guidelines[91] established by the NSC states that the air radiation dose rate, the atmospheric concentration of radioactive materials and the radioactivity concentration of environmental samples (drinking water, leafy vegetables, raw milk and rainwater) shall be measured as soon as possible immediately after a nuclear emergency and decisions regarding protective measures of what should be done and how it should be done shall be determined based on the measured cumulative exposure. In addition, the manual for radiological environmental monitoring in an emergency, prepared

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88 The National Basic Disaster Prevention Plan states that the NE Guideline established by the NSC shall be fully respected to determine professional and/or technical matters.

89 The index for restrictions on the intake of food and beverages was established in 1998 based on guidelines from the NSC Environmental Working Group Specializing in Disaster Prevention Measures for Nuclear Power Stations.

90 It is explained that any food that involves an extended period of time between the incorporation of radioactive materials and the time of shipment was excluded.

91 The National Basic Disaster Prevention Plan states that the NE Guideline established by the NSC shall be fully respected to determine professional and/or technical matters.

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by the Fukushima prefectural government, states that as soon as the government is informed of the occurrence of a specific incident, an emergency monitoring project shall be developed and implemented to determine the necessity of urgent actions and that the following items shall be measured: radioactive iodine and radioactive cesium included in environmental samples (drinking water, leafy vegetables, raw milk and rainwater), the air radiation dose rate and the concentration of radioactive iodine in the air.

b. Detecting a high level radioactivity in plants

In response to the current nuclear accident, from March 12, emergency monitoring activities to measure the air radiation dose rates and perform dust sampling were conducted at local sites. However, there was no monitoring of leafy vegetables or raw milk[92].

On March 15, the Fukushima prefectural government collected weeds and measured them. As a result, radioactive materials that far exceeded the index values for placing restrictions on the intake of food and beverages were detected in weeds that had been collected at a location beyond a 30km radius of the Fukushima Dai-ichi NPS.

In response to this, the Fukushima prefectural government was worried about food and beverages contaminated with radioactive materials. During that time, however, there were only two germanium semi-conductor detectors available to measurethe radioactivity, and local government officials were not ready to monitor a wide range of food and beverages. Hence, the local government asked the NERLHQ to perform monitoring of food and beverages, which, under ordinary circumstances, they should have done themselves. In response to this request, the NERLHQ decided to ask the Japan Chemical Analysis Center (JCAC) to perform monitoring of food and beverages. Thus through the mutual cooperation of both the NERLHQ and the Fukushima prefectural government, full-scale implantation of food and beverage monitoring began in Fukushima Prefecture.

The Ministry of Agriculture, Forestry and Fisheries (MAFF) designed a framework[93] in

[92] The Fukushima prefectural government staff in charge of this matter explained that this was because "we thought we had to analyze air dust first due to the very limited number of measurement instruments and equipment available."

[93] Initially, the two monitoring institutes were able to test a total of about forty samples a day.

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which the full cost of monitoring would be borne by MAFF and all food products produced in local municipalities other than Fukushima Prefecture would be transported to and measured by JCAC and/or the National Institute for Agro-Environmental Sciences (NIAES). Municipalities successively started to contact measurement institutions themselves seeking cooperation in performing monitoring of food and beverages.

c. Provisional regulation value for food and beverages

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

On March 15, as described above, a high concentration of radioactive materials was detected in weeds that had been collected in Fukushima Prefecture. The MHLW staff in charge of this matter thought some action should be taken with regard to the radioactive contamination of food. They determined, however, that any action should be consistent with the Act on Special Measures Concerning Nuclear Emergency Preparedness. In other words, they did not imagine that any action could be taken on the basis of the Food Sanitation Act. Meanwhile, MAFF was worried that agricultural products might be seriously impacted by rumors. Hence, they determined that in order to prevent agricultural products from being negatively affected by rumors, it was necessary to develop general criteria for deciding whether or not any food in question should be allowed to be distributed within disaster-affected regions as well as to non-affected regions. On March 16, MAFF strongly urged the MHLW to implement criteria for food exposed to radioactive materials in accordance with the Food Sanitation Act. In addition to this urgent request from MAFF, the MHLW itself determined that it was necessary to examine food distributed in a wide range of areas on the basis of the Food Sanitation Act and decided to examine the adequacy of criteria for radioactive material as prescribed in the Act. Finally, the MHLW decided that the index for restrictions on the intake of food and beverages, which the NSC had implemented based on the simulation of a nuclear accident within Japan, should be adopted in order to take swift and appropriate action and solve the current emergency situation. The MHLW decided to adopt the Index as the provisional regulation

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value for food and beverages in accordance with the Food Sanitation Act. The MHLW naturally took into consideration the significant potential effects of radioactive iodine on childhood thyroid cancer and adopted the Codex Index[94] (100Bq/kg as the criterion for all food and beverages in terms of radioactive iodine). The MHLW also decided that milk and dairy products exceeding the criterion of 100Bq/kg should not be used for modified dry milk for infant or for milk to be directly consumed. Additionally, on March 17, the MHLW issued a notice to all prefectural governments to the effect that the index value indicated by the NSC should be adopted as a temporary provisional regulation value (hereinafter referred to as "provisional regulation values") and that any food or beverages exceeding this criteria should not be provided for human consumption pursuant to Paragraph 2 of Article 6 of the Food Sanitation Act.

In terms of the Basic Food Safety Act, the MHLW did not have to ask the Food Safety Commission for advice (hereinafter referred to as "Advice") on the effects of the implemented provisional regulation values on food security and health. However, the MHLW decided that it was proper to ask for arbitrary advice in accordance with Paragraph 3 of Article 24 of the same Act. On the other hand, Article 11 of the Act stipulates that in a situation where the MHLW must ask the Food Safety Commission for advice, the MHLW does not have to comply in the event of an exceptionally urgent case. The MHLW implemented the provisional regulation values after deciding that they had to take urgent action on food and beverages contaminated with radioactive materials[95].

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

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[94] Codex Standards, which include food standards, guidelines and codes of practice to protect the health of consumers and ensure fair trade practices in food trade, are implemented by the Codex Alimentarius Commission established by the United Nations, FAO and WHO.

[95] Thus the provisional regulation value, which had been implemented without advice from the Food Safety Commission, is called a "provisional regulation value."

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d. Provisional regulation value for seafood

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

As described above, the NSC Indices for restricting the intake of food and beverages contain no criteria for the restriction of seafood contaminated with radioactive materials nor do the provisional regulation values based on the Indices for restricting the intake of food and beverages. Hence, the MHLW decided that it was necessary to implement temporary regulation values for seafood in terms of radioactive iodine and thus began an urgent discussion with the NSC. As a result of the discussion, the MHLW decided to adopt 2,000Bq/kg as a criterion value for seafood in terms of radioactive iodine, with the understanding that a criterion value of 300Bq/kg for drinking water, milk and dairy products, and a criterion value of 2,000Bq/kg for vegetables in terms of radioactive iodine were already implemented as regulation values and could be used as references, and because both seafood and vegetables were classified as solid food,. On April 5, on the basis of the advice[96] of the NSC, the MHLW issued a notice to all local governments to the effect that provisional regulation values for seafood in terms of radioactive iodine should be 2,000Bq/kg and that any seafood exceeding this criterion should not be provided for human consumption pursuant to Paragraph 2 of Article 6 of the Food Sanitation Act.

e. Provisional regulation values for tea

Tea was classified as "other" in the Index for restricting the intake of food and beverages. The provisional regulation value for tea was 500Bq/kg. On May 11 of the same year, radioactive cesium exceeding the provisional regulation value of 500Bq/kg was detected in

[96] The NSC has maintained one-third of 50mSv of thyroid gland equivalent dose (refer to Section 4 (1) c above), which has been the intervention radiation dose level for food outside the three categories as defined in the Index for restrictions on the intake of food and beverages, since the NSC first developed the Index values. The NSC obtained calculation results indicating that radiation dose would be within the maintained value even if an additional 2,000Bq/kg were ingested from seafood for one year. Thus, the NSC replied to the effect that a criterion value of 2,000Bq/kg for vegetables could provisionally and safely be applied to the index value for seafood in terms of radioactive iodine using the Index for restricting the intake of food and beverages as a reference.

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green tea leaves produced in Kanagawa Prefecture. In response to this, the MHLW asked fourteen local governments to perform more intensive monitoring of green tea leaves. Additionally, on May 13, radioactive cesium exceeding the provisional regulation value was detected in unrefined tea leaves produced in Kanagawa Prefecture. In response to this, on May 16, the MHLW asked fourteen local governments to perform monitoring of unrefined tea leaves to restrict the distribution of unrefined tea leaves that exceeded the provisional regulation value (500Bq/kg).

Because unrefined tea leaves were monitored with the same criteria as green leaves, there was a consensus among the relevant local governments[97] and within the national government that monitoring unrefined tea leaves according to the same criteria as green leaves did not fit reality based on the following reasoning: unrefined tea leaves may have a concentration of radioactive cesium five times greater than that of green leaves because they are dry-processed; and tea, which is nearly always for drinking, is prepared by steeping tea leaves in hot water reducing concentration levels. However, on June 2 of the same year, the MHLW issued a notice to the effect that the same temporary regulation value should be applied to all types of tea leaves including unrefined tea leaves on a regular basis. Relevant industry groups, worried that tea products might be negatively affected by rumors, strongly recommended the monitoring of tea leaves. Ultimately, all local governments decided to perform monitoring of unrefined tea leaves.

f. Restriction of tap water intake

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

On March 18 of the same year, 170Bq/kg of radioactive iodine was detected in tap water that had been collected in Fukushima-shi on March 16. In response to this, the MHLW started to discuss developing criterion values for tap water just as they had for

[97] Some municipalities, which had believed that monitoring unrefined tea leaves according to the same criteria as green leaves had little scientific basis, initially refused to monitor unrefined tea leaves. However, relevant industry groups strongly urged them to reconsider and eventually each of them decided to comply.

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food and beverages. On March 19, the MHLW notified all municipalities of "Measures to be taken for tap water to protect citizens from radiation exposure resulting from the Fukushima Dai-ichi NPS and Fukushima Dai-ni NPS," which included: (i) refraining from drinking tap water exceeding index values indicated by the NSC (300Bq/kg of radioactive iodine, 200Bq/kg of radioactive cesium); (ii) tap water may be used for domestic use without any concern; and (iii) drinking tap water is not restricted if there is no access to alternative drinking water[98].

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

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

Subsequently, based on the results of that monitoring, the MHLW asked municipalities to restrict the intake of tap water if their tap water supply was found to contain levels exceeding the index value[99].

On April 4 of the same year, based on up-to-date monitoring results, the MHLW issued

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[98] The notice provided by the MHLW states that criterion values for radiological protection established by the International Commission on Radiological Protection (ICRP) on which the index values indicated by the NSC are based, took into consideration the effects of long -erm exposure to radiation; the temporary intake of water exceeding the ICRP index may not have any effect on human health; and the intake of tap water based on the "Principles for Intervention for Protection of the Public in a Radiological Emergency" may not be restricted in a situation where safe alternative drinking water is not easily available and there is serious concern for human health as a result.

[99] On March 21, the MHLW asked Iitate-mura village office in Fukushima Prefecture to restrict the intake of tap water and then asked the Fukushima, Ibaraki, Chiba, and Tokyo prefectural governments to restrict the intake of tap water by infants in certain areas in each prefecture.

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a "Future monitoring policy on radioactive materials in tap water[100]," in which monitoring policy, intake restrictions and guidelines for lifting restrictions were stipulated (this policy was revised on June 30 of the same year, based on the premise that the effects of the Fukushima Dai-ichi NPS accident were going stabilize.

g. Shipping restrictions

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

On March 15, a high concentration of radioactive material was detected in weeds that had been collected (refer to b above). On March 17 of the same year, the NERHQ r started[101] a discussion on measures to be taken for contaminated food and beverages

On March 19 and 20, radioactive material exceeding the temporary regulation value was detected in: (i) raw milk from Fukushima prefecture; (ii) spinach from Ibaraki, Tochigi and Gunma prefectures; and (iii) leafy vegetables from Gunma prefecture. In response to this, on March 21, head of the Government Emergency Response Center provided the leaders of the Fukushima, Ibaraki, Tochigi, and Gunma prefectural governments with instructions to restrict shipment based on Paragraph 3, Article 20 of the Act on Special Measures Concerning Nuclear Emergency Preparedness, of (i) raw milk from Fukushima prefecture,

[100] The MHLW: (i) requested local governments to carry out monitoring of tap water mainly in Fukushima Prefecture and its neighboring ten prefectures more than once a week; (ii) requested water operators to implement intake restrictions and notify affected residents of these restrictions if radioactive material in the tap water exceeded the guideline values for three consecutive days; (iii) decided to lift restrictions if monitoring findings averaged below the provisional limit values for three consecutive days and if monitoring results indicated that monitoring findings showed signs of decreasing.

[101] The framework designed within the national government to issue instructions to restrict the shipment of food and beverages was as follows: local municipalities are to perform monitoring of food and beverages; monitoring results are to be collected, aggregated, and unified by the MHLW; unified monitoring results are to be reported to the NERHQ; the NERHQ will evaluate monitoring results to determine whether or not provisional regulation values of Food Sanitation Act have been exceeded; and if exceeded, the NERHQ will ask the NSC for advice, and, if necessary, the head of the NERHQ will issue instructions to all relevant municipalities to restrict the shipment and intake of food and beverages, based on Paragraph 3, Article 20 of the Act on Special Measures Concerning Nuclear Emergency Preparedness.

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and (ii) spinach and leafy vegetables from Ibaraki, Tochigi and Gunma prefectures[102]. Additionally, on March 22, it was discovered that a high concentration of radioactive material was detected in some vegetables from Fukushima Prefecture. On March 23, the Government Emergency Response Center provided the head of Fukushima prefectural government with instructions to restrict the shipment and intake of certain vegetables. Subsequently, instructions to restrict shipment were successively issued.

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

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

It was discovered that lower levels of radioactive iodine were detected in food and beverages while radioactive cesium exceeding provisional regulation values was detected

[102] The range of monitoring results was not always consistent with shipment restrictions. For example, if the shipment of spinach from three other prefectures were restricted, then spinach from Fukushima was also restricted even if its monitoring results were not arrived ,, as it was presumed to have a higher level of radioactivity, because of its proximity to the Fukushima Dai-ichi NPS.

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

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

h. Other problems concerning shipping restrictions

(a) Farm animals(cattle) feed

On March 19 of the same year, MAFF provided cattle farmers with a "Notice on farming management" (hereinafter referred to as "Notice on Farming Management") via prefectural governments in the Tohoku and Kanto[103] districts to the effect that in order to prevent or reduce contamination of livestock products with radioactive material, cattle raised in regions where airborne radiation levels higher than normal have been detected shall be fed with hay from grass that has been cut, gathered and stored prior to the date of the nuclear accident in Fukushima Prefecture and stored indoors beyond that date; drinking water for cattle shall be kept in a sealed water tank to prevent falling dust

[103] This notice was sent to six prefectural governments in the Tohoku district under the jurisdiction of the Tohoku Regional Agricultural Administration Office (Aomori, Iwate, Miyagi, Akita, Yamagata and Fukushima) and ten prefectural governments in the Kanto district under the jurisdiction of the Kanto Regional Agricultural Administration Office (Ibaraki, Tochigi, Gunma, Saitama, Chiba, Tokyo, Kanagawa, Nagano, Yamanashi and Shizuoka). It was also sent to other prefectural governments from the Agricultural Administration Offices as a reference. Therefore, this notice was only meant as a reference for cattle farmers in Niigata Prefecture.

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particles from entering; and cattle will not be sent to graze until further notice.

Additionally, on April 14 of the same year, MAFF provided cattle farmers with a notice via prefectural governments in the Tohoku and Kanto districts to the effect that in order to prevent or reduce the contamination of cattle with radioactive material via farm coarse feed (including pasture grass and straw), a provisional permissible value[104] of radioactive material contained in farm coarse feed (including pasture grass and straw) would be established, and that values of radioactive material contained in farm coarse feed that is produced hereafter shall, if used for cattle, be below the prescribed provisional permissible value.

Additionally, on August 1 of that year, prior to the upcoming rice and wheat fall harvest season, MAFF notified all prefectural governments that in order to prevent contamination of cattle with radioactive material via rice bran and wheat bran, aprovisional permissible value[105] of radioactive material contained in farm coarse feed as well as in cattle feed including rice bran and wheat bran shall be established. MAFF also notified all prefectural governments that the use, production, or distribution of cattle feed exceeding provisional permissible values shall be avoided.

(b) Measures for beef

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

The root of this problem was that the Notice on Farming Management was only addressed to cattle farmers. The Notice was not communicated to grain farmers, who produced rice straw. Furthermore, information and guidance provided to cattle farmers

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[104] The notice also prescribes that, in terms of dairy cattle feed, the provisional permissible value of radioactive iodine and radioactive cesium shall be 70Bq/kg and 300Bq/kg, respectively, in terms of commercial cattle feed, the radioactive cesium value will be 300Bq/kg, and in terms of cattle feed for cattle other than dairy cattle and commercial cattle, the radioactive cesium value will be 5,000Bq/kg.

[105] The notice also prescribes that the maximum provisional permissible value of radioactive cesium contained in feed for commercial cattle, horses, pigs, domestic fowls and other domestic animals shall be 300Bq/kg and 100Bq/kg in feed for cultured fishes.

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was inadequate and it was discovered that cattle farmers had fed their cattle rice straw that had been stored outdoors and most likely contaminated with radioactive material.

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

On August 4 the NERHQ updated their notice on "Strategies for monitoring planning, developing shipping restrictions and abolishing shipping restrictions, on the basis of products and regions" (established on April 4 of the same year, revised on June 27 of the same year (refer to Section g above)) and agreed to partially lift shipping restrictions based on the premise that all cattless or all cattle farms would be tested[106].

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

(c) Measures for rice harvested in 2011

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

[106] One or more of the commercial cattle first shipped is tested on a per-farm based.

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

In August of the same year, MAFF released a plan to conduct a two-stage research process due to the following circumstance: rice is a staple food, a large amount of rice is grown and eaten in Japan and there are various types of distribution systems in Japan. In the first stage, prior to the upcoming rice fall harvest season in 2011, a preliminary survey[107] should be conducted to study the trends in the concentration of radioactive material. In the second stage, a main survey[108] should be conducted to determine whether or not shipping restrictions are required after the rice harvest. In the main survey, the provisional regulation value was not exceeded in any region. However, on and before November 30 of the same year, radioactive cesium exceeding the provisional regulation value was detected in unpolished rice (not tested by direct sampling in the main survey) that was produced in Fukushima-shi (formerly Oguni-mura) and Date-shi (formerly Oguni-mura and Tsukidate-mura). In response to this situation, the NERHQ instructed the Fukushima prefectural government to restrict the shipment of rice produced in these aforementioned regions in 2011.

(2) Contamination of soil, etc.

a. Schoolyards and the other educational facilities in Fukushima Prefecture

Fukushima Prefecture requested the NERLHQto indicate the criteria for reopening the schools and the other educational facilities in the prefecture. In response to the request, MEXT began to consider the criteria.

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[107] The following decisions were made: (i) municipalities that have been instructed to restrict shipment, (ii) their neighboring municipalities, and (iii) those cities, towns and villages of other municipalities where radioactive cesium contained in farmland soil exceeds 1,000Bq/kg as well as where airradiation dose rates exceed 0.1μSv/h, should perform a similar survey for three consecutive days,one week prior to harvesting. Those municipalities whose results indicate a value exceeding 200Bq/kg shall be "regions requiring an intensive survey" for the main survey and those whose results indicate a value below 200Bq/kg shall be "regions requiring a basic survey."

[108] In "regions requiring an intensive survey" one sample was collected per approximately 15ha and in "regions requiring a basic survey" samples were collected per city, town, or village based on previous smaller populations, which preceded the merging of many villages and towns into larger cities (an average of seven samples per municipality).

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

At the time, MEXT believed that it was necessary to consider the consistency of the criteria for the establishment of the planned evacuation area, which was deliberated within the Government, and the contribution of internal exposure. On April 11, the NERHQ specified the area where the cumulative radiation dose may exceed 20mSv as the planned evacuation area based on the criteria of 20-100mSv that had been established by the ICPR in the event of an emergency when evacuation is required (a reference level for public exposure in the event of an "radiation emergency situation" in the recommendation issued in 2007). MEXT decided 20mSv/year, which is the upper limit established by the ICPR for a situation after an accident has stabilized (a reference level for public exposure in the event of an "exiting exposure situation" in the recommendation issued in 2007) as the criterion[109·110]. Further, MEXT estimated that the contribution of the internal radiation dose to the whole radiation dose is 0 to 5.6% (2.2% on average). Because this contribution was small, the Ministry decided not to take the effect of internal exposure into consideration and to calculate the total exposure as external exposure. Assuming a student stays indoors for 16 hours and outdoors (in schoolyard) for eight hours a day, an air radiation dose rate of 3.8μSv/h corresponds to 20mSv/year of exposure. Therefore MEXT decided to adopt this

[109] When establishing the criterion of 20mSv/year, MEXT took the risk of confusing the local governments when the national government indicated a criterion that was too low into consideration because the Fukushima Radiation Health Risk Adviser explained that exposure below 100mSv does not affect health.

[110] The Education Minister explained in parliament that 20mSv/year, which is the lower limit of the reference level of 20 - 100mSv/year, was the starting point of the deliberation on the criterion. It is now under investigation as to why such an explanation was made.

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value as a guide. Furthermore, the Ministry considered that "it is appropriate to decrease the dose rate that students are exposed to as much as possible while adopting the criterion of 1 - 20mSv/year as the reference level after an emergency situation has stabilized as a tentative guideline," and "even if an air radiation dose rate exceeding 3.8μSv/hour is measured, the level that students are exposed to can be limited to 20mSv/year by taking countermeasures to ensure activities are mainly done indoors." Based on this consideration, MEXT established the "Provisional view regarding the judgment of the use of schoolyards and educational facilities in Fukushima Prefecture" indicating that: (1) activities in the schoolyard should be restricted to approximately one hour a day when an air radiation dose rate exceeding 3.8μSv/h is detected in the schoolyard, and (2) the schoolyard can be used as usual when an air radiation dose rate below 3.8μSv/h is detected. MEXT submitted this provisional view to the NSC via the NERHQ and asked for its advice on April 19. This view meant that no upper limit was established on the air radiation dose rate for schoolyards that can be used as per (1) above, and the schoolyard can be used without any limitation when the air radiation dose rate is less than 3.8μSv/h as per (2).

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

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

On May 11, MEXT suggested two measures for the surface soil in the schoolyard, "to intensively gather and store underground" and the "upside-down replacement method," as effective exposure reduction methods based on the result of the investigation conducted by JAEA. On May 27, the Ministry decided to provide financial support to the owners of

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