Annex 2

# Expert Meeting on Radiological Protection for Decontamination and Related Works

# The Second Report

April 2012

Expert Meeting on Radiological Protection for Decontamination and Related Works

# I. Outline of expert meeting and participants

## Expert meeting on radiological protection for decontamination and related works

## Outline of the expert meeting

**1. Objectives**

The "Ordinance on Prevention of Ionizing Radiation Hazards at Works to Decontaminate Soil and Wastes Contaminated by Radioactive Materials Resulting from the Great East Japan Earthquake and Related Works" (hereinafter referred to as the "Ionizing Radiation Ordinance for Decontamination") came into effect on 1 January 2012 for radiological protection for workers assigned to decontamination related works, including collecting wastes that are contaminated by radioactive materials discharged by the accident at the Tokyo Electric Power Company (TEPCO) Fukushima Daiichi Nuclear Power Plant Associated with the Great East Japan Earthquake on 11 March 2011. In relation to the revision of the evacuation areas, the following are expected to be sequentially commenced at special decontamination areas: restoration of public infrastructure, hospitals and welfare facilities operations, manufacturing, agriculture and forestry operations, intermediate treatment of waste, repairs and maintenance works, and transportation and other works. It has become necessary to take actions to protect workers involved in these categories of works from radiation hazards.

Therefore, the MHWL will call for participation from experts to discuss ways of taking such actions to protect workers engaged in infrastructure restoration and other works at the special decontamination areas.

**2. Review items**

(1) Scope of the work

Work relating to the operations listed below at special decontamination areas

a. Disaster restoration such as reconstruction of infrastructure
b. Manufacturing operations to ensure and maintain employment
c. Facilities for residents such as hospitals, welfare facilities and shops
d. Agriculture and forestry
e. Disposal of waste
f. Repairs and maintenance work, transportation, and other works

(2) Review on the scope of radiation hazard prevention measures and description of the best suited measures

a. Work handling contaminated materials similar to decontamination works such as excavating soil
b. Outdoor works excluding tasks similar to decontamination works
c. Indoor works such as manufacturing
d. Works conducted in places which involves radioactive sources such as disposal facilities of contaminated waste

**3. Participants in the expert meeting**

(1) Director of the Occupational Safety and Health Department, Labour Standards Bureau, MHLW, shall hold this meeting by calling for the participants listed in the attachment.
(2) A chairperson shall be appointed who organizes the agenda.
(3) Participants can be added to the meeting when necessary.
(4) Participants other than those listed can be invited to the meeting session.

**4. Others**

(1) The meeting sessions are in principle open to the public. However, closed sessions can be held when personal information and commercially sensitive information are on the agenda.
(2) The administration of the meeting is handled by the Industrial Health Division, Occupational Safety and Health Department, Labour Standards Bureau, MHLW.

Participants

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|---|---|
| Masahiro Osako | Director, Center for Material Cycles and Waste Management Research, National Institute for Environmental Studies |
| Shinji Kaneko | Director, Department of Forest Site Environment, Forestry and Forest Products Research Institute |
| Kyo Kobayashi | Contract researcher, Central Agricultural Research Center, National Agriculture and Food Research |
| Nobuyuki Sugiura | Head, Research Center for Radiation Emergency Medicine, National Institute of Radiological Sciences |
| Kazuyoshi Tateyama | Professor, Department of Environmental System Engineering, Ritsumeikan University |
| Toshio Nagoya | Professor, Faculty of Science and Engineering, Waseda University |
| Sadaaki Furuta | Director, Nuclear Fuel Cycle Engineering Laboratories Tokai Research and Development Center Japan Atomic Energy Agency |
| Yoshimi Matsuura | Advisor, Technology Institution of Industrial Safety |
| Koji Mori | Professor, Occupational Health Training Center University of Occupational and Environmental Health, Japan |
| Toshiyuki Monma | Chief Engineer, Fukushima Environmental Safety Center, Headquarters of Fukushima Partnership Operations, Japan Atomic Energy Agency |

Observers

| | |
|---|---|
| Takashi Ozawa | Counselor to Director General, Reconstruction Agency |
| Osamu Sudo | Counselor, Nuclear Disaster Victims Support Team (Residence Support), Nuclear Emergency Response Headquarters, Cabinet Office |
| Hidekazu Chayama | Team Leader, Nuclear Disaster Victims Support Team (Radiation) Nuclear Emergency Response Headquarters, Cabinet Office |
| Mitsutoshi Ide | Head, Forestry Labor Office, Management Division, Forestry Agency (attended the $7^{th}$, $8^{th}$ and $9^{th}$ meetings) |
| Masateru Iguchi | Assistant Manager, Management Division, Forestry Agency (attended the $10^{th}$ meeting) |
| Sumito Yasuoka | Head, Agricultural Production Promotion Office, Agricultural Production Bureau, |

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| | Ministry of Agriculture, Forestry and Fisheries<br>(attended the 7th meeting) |
| Seiji Tazo | Assistant Manager, Technology Policy Division,<br>Agriculture, Forestry and Fisheries Research Council<br>Ministry of Agriculture, Forestry and Fisheries<br>(attended the 8th , 9th and 10th meetings) |
| Yuichi Ishikawa | Construction Works Inspector, Construction System Management Office, Engineering Affairs Division,<br>Ministry of Land, Infrastructure and Transport<br>(attended the 9th and 10th meetings) |

# II. Timeline of meeting sessions

The 7th review meeting session: 8 March 2012
The 8th review meeting session: 27 March 2012
The 9th review meeting session: 6 April 2012
The 10th review meeting session: 20 April 2012

# III. Matters to be incorporated into the measures

## Section 1 Objectives

The Ionizing Radiation Ordinance for Decontamination came into effect on 1 January 2012 for the prevention of radioactive hazards for workers engaged in decontamination related works, including collecting wastes that are contaminated by radioactive materials discharged by the accident at the Tokyo Electric Power Company (TEPCO) Fukushima Daiichi Nuclear Power Plant associated with the Great East Japan Earthquake on 11 March 2011. In relation to the revision of the evacuation areas, the following are expected to be sequentially commenced at special decontamination areas: restoration of public infrastructure, hospitals and welfare facilities operations, manufacturing, agriculture and forestry operations, intermediate treatment of waste, repairs and maintenance works, and transportation and other works. It has become necessary to take appropriate actions for protecting workers involved in these categories of works from radiation hazards.

The measures should be established for implementing matters such as exposure dose control, work related actions and medical examinations that are necessary to protect workers from radiation hazards when employers assign workers to handle soil for which radioactivity concentration is above a certain level or to work in areas where the ambient dose rate is at a certain level. They include not only matters to be stipulated in laws and regulations, but also those that should be implemented actively and to be included in guidelines. The measures aim at protecting workers from ionizing radiation hazards, and they are also intended to be applicable to individual proprietors, self-employed individuals and voluntary workers.

The measures have been reviewed based on limited information in a limited time period. They will be reviewed in the future where appropriate along with continuously gathering new information and knowledge.

## Section 2 Scope

The measures proposed in this report aim at employers who are not involved in decontaminating soil or collecting waste, but involved in works including: (a) handling contaminated soil with a radioactivity concentration exceeding 10,000 Bq/kg (hereinafter referred to as “works for handling

designated contaminated soil and wastes") and (b) works at places where the average ambient dose rate exceeds 2.5μSv/h (hereinafter referred to as "works under a designated dose rate", excluding works for handling designated contaminated soil and wastes) in special decontamination areas or intensive contamination survey areas under the provisions of Article 25, paragraph 1 and Article 32, paragraph 1 respectively of the Act on Special Measures Concerning Handling of Environmental Pollution by Radioactive Materials Discharged by the Nuclear Power Station Accident Associated with the Tohoku District Off the Pacific Ocean Earthquake that Occurred on 11 March 2011 (Act No. 110, hereinafter referred to as "Act on Special Measures Concerning the Handling of Radioactive Pollution").

Employers who assign their workers to diving work in the surrounding sea area of the TEPCO Fukushima Daiichi Nuclear Power Plant shall measure external exposure dose of those workers and record the results of the measurements.

(Note): According to the sea water monitoring conducted by the Ministry of Education, Culture, Sports, Science and Technology in the surrounding sea area of the plant (within 30 km radius) and offshore at Miyagi, Fukushima and Ibaraki Prefectures, the radioactivity concentration was below 0.1 Bq/L. That of the soil of the sea bottom in the area around the plant (within 30 km radius) was around a few hundred Bq/L. These figures are well below the lower limit of the permitted radioactivity concentration (10,000 Bq/kg) and the surface contamination limit (40 $Bq/cm^2$). Also, the duration of each diving work period is short and the work is conducted intermittently. Based on the information available at present, radiation exposure doses from diving work are presumed to be well below the level that requires exposure dose control (5 mSv/y). Therefore, the law will not apply to diving work in the meantime. However, efforts will be continuously made to collect information and radiation exposure doses are to be controlled using guidelines. The "surrounding sea area" is defined as 30 km in radius from the Fukushima Daiichi Nuclear Power Plant in the meantime.

(Note): The existing ordinance shall be applicable to "Works of decontamination, etc." or "works for collecting wastes, etc." defined by the Ionizing Radiation Ordinance for Decontamination.

(Note): "Contaminated soil and wastes" means soil, fallen leaves and branches and sludge deposited in water channels that are contaminated by radioactive materials discharged by the nuclear accident (hereinafter referred to as "radioactive materials discharged by the accident").

(Note): "Works for handling contaminated soil and wastes" means that workers touch contaminated soil directly with their hands or by using machines, devices and tools that are in touch with soil and they may be exposed to dust containing contaminated soil. In particular, the work includes felling and pruning trees, cutting grass, plowing farm land, and removing surface soil; digging, removing, clearing and transporting earth and sand, vegetation and debris; collecting, transporting and storing contaminated soil; washing, removing, scraping off roofs, external walls, and concrete and asphalt surfaces; dismantling buildings and structures; capping

contaminated soil and covering the surface of structures. However, temporary work involving any of the above is not applicable to the "works for handling contaminated soil and wastes" (i.e. construction where the main work does not involve earth work).

(Note): The average ambient dose rate shall be measured at the area where the workers are actually engaged in their work. This means that the rate shall be measured indoors for indoor work and outdoors for outdoor work.

(Note): The work involving surveying, measuring and investigations conducted in an area where the average ambient dose rate exceeds 2.5 μSv/h falls under "works under a designated dose rate". In the areas where average ambient dose rate is less than 3.8 μSv/h at which the Nuclear Emergency Response Headquarters controls the re-commencement of manufacturing operations, the average ambient dose rate indoors is presumed to be less than 1.52 μSv/h, about 40 % of the above rate. Therefore, when appropriate actions such as decontaminating the workplaces are taken prior to starting business, indoor manufacturing operations are not presumed to fall under the works under a designated dose rate.

(Note): Transportation businesses will not fall within the works for handling designated contaminated soil and wastes when drivers are responsible only for driving vehicles. However, the following work will fall within the works under a designated dose rate, and exposure dose control is required for work conducted in the areas where the average ambient dose rate exceeds 2.5μSv/h:

① The load carry-in or carry-out points (excluding the points associated with restoration work of infrastructures) located in the areas where the average ambient dose rate exceeds 2.5 μSv/h and workers are expected to work in the area for 40 hours or longer per month.

② Workers engaged in transporting loads related to infrastructure restoration work in the areas where the average ambient dose rate exceeds 2.5 μSv/h (due to the nature of the operations, workers are expected to work in the areas with high ambient dose rates).

［Staying in an area where the average ambient dose rate is 5 μSv/h for about 1,000 hours per year (about 83 hours per month) or an area where the rate is 9.5 μSv/h for about 520 hours per year (about 43 hours per month) will result in the radiation exposure dose exceeding 5 mSv/y, requiring control of radiation exposure dose. Therefore, the reference working hours was established as 40 hours a month so that the radiation exposure dose will not exceed 5 mSv in a year, even when presuming the most conservative rate of 9.5 μSv/h in the restricted residential areas where manufacturing will be resumed. For infrastructure restoration works, workers may have to work in the areas where the average ambient dose rate exceeds several tens of μSv/h, and therefore the work is defined as works under a designated dose rate regardless of the time spent by workers in that particular areas.]

The case when just passing through a point where the average ambient dose rate exceeds 2.5 μSv/h does not fall within the works under a designated dose rate, because the time spent at that point is minimal and entry is prohibited for any area where the dose rate exceeds 9.5 μSv/h.

# Section 3 Objectives and Methods for Exposure Dose Control

## 1. Principles

(1) Employers shall strive to minimize the ionizing radiation received by workers.

(2) When implementing works for handling designated contaminated soil and wastes or those under a designated dose rate, employers shall give priority to the minimization of the radiation exposure dose received by workers and shall strive to take measures such as decontaminating workplaces in advance.

(Note): The (1) above states that when employers perform their work, they shall keep radiation exposure as low as reasonably achievable based on the principles of optimization of the International Commission on Radiological Protection (ICRP).

(Note): The (2) above states that when work is expected to have a certain level of radiation exposure, it is necessary to prioritize in minimizing such doses received by workers under a designated dose rate and strive to implement decontamination measures, based on the principles of justification established by ICRP prior to starting the work, as the public benefit and necessity of the work outweighs its demerits. However, given that work restoring water and roads as a part of the works for handling designated contaminated soil and wastes is essential to progress in decontamination and restoration and given the high public benefit and necessity, there may be cases where pre-decontamination measures cannot be implemented. Also, works such as capping soil, paving and turning and plowing of farmland that has the expected effect of reducing exposure doses as much as or greater than decontamination measures, it is deemed that decontamination measures are being implemented at the same time when these works are conducted.

(Note): In light of the principles of justification, employers who assign works other than the above exempted works (manufacturing, commercial activities and farming) are required to decontaminate workplaces in advance, decrease exposure doses to the lowest possible level, and in principle operate in the areas where the ambient dose rate is less than 2.5 μSv/h, so there is no need for exposure dose control, given that workers in these types of businesses tend to have higher exposure doses associated with long hours of work, and the work is not necessarily urgent.

(Even in restricted residence areas where the average dose rate is the maximum limit, 9.5μSv/h, the dose rate is expected to become lower by 30-40 %, if the areas are decontaminated. And, the indoor ambient dose rate is about 40 % of that outdoors. Therefore, when areas are appropriately decontaminated, the indoor dose rate is presumed basically not to exceed 2.5 μSv/h)

(Note): There is no need to conclude a separate contract for decontamination related works to be conducted in advance. The work can be included as a part of the works for handling designated contaminated soil and wastes.

## 2. Measurement of radiation exposure dose

(1) Employers who assign works for handling designated contaminated soil and wastes or works under a designated dose rate (hereinafter referred to simply as "employers") shall measure the radiation exposure doses of their workers by methods prescribed for each case of a) to c) below.

(Note): 2.5μSv/h is not the limit of the radiation exposure dose. It is the value from which measurements are started for the reduction of the radiation exposure doses for workers to the as low as reasonably achievable level, such as controlling personal doses (monitoring). Unlike the general public, workers are obliged to engage in work associated with exposure to radiation under the direction of their employers based on their contract with their employers. Especially those who are employed in outdoor type industries for which the workplace is not fixed may be engaged in works at places with the average ambient dose rate of a few μSv/h, or handling highly radioactive contaminated soil and wastes with a few hundred thousand Bq/kg, and therefore may have exposure doses exceeding 50 mSv in a year. Therefore it is necessary to control their exposures so as not to exceed the limit.

**a)** Cases where workers are assigned to the works for handling designated contaminated soil and wastes at the areas where the average ambient dose rate exceeds 2.5 μSv/h (equivalent to 5 mSv/y calculated on the basis of 2000 h/y)

(Note): See Annex 2 for the measurement basis of the average ambient dose rates.

・External exposure doses: Measurement with personal dosimeters

(Note): The method of measurement shall be the same as that specified in the Ordinance on Prevention of Ionizing Radiation Hazards (the MHLW Ordinance No. 41, 1972, hereinafter referred to as the "Ionizing Radiation Ordinance").

・Internal exposure dose: Measurement depending on the specific work involved and radioactivity concentration level of the soil handled by workers

**b)** Cases where workers are assigned to works for handling designated contaminated soil and wastes in the areas where the average ambient dose rates exceeds 2.5 μSv/h

・External exposure dose: Measurement with personal dosimeters

**c)** Cases where workers are assigned to works for handling designated contaminated soil and wastes in the special decontamination areas where the average ambient dose rate is less than 2.5μSv/h (limited to the cases where workers are normally expected to work in areas where the average ambient dose rate is higher than 2.5μSv/h, given the nature of the work, such as restoration work on local infrastructure).

・External exposure: Measurement with personal dosimeters. The evaluation based on the ambient dose or measurement of radiation exposure doses for a representative worker may also be acceptable.

(Note): Of works for handling designated contaminated soil and wastes, restoration of the local

infrastructure or related repair work is included in the work that workers are expected to be engaged in at areas where the average ambient dose rates exceed 2.5 μSv/h.

(Note): There is no need for exposure dose control for manufacturing work being conducted only at the specific areas along with the related repair and transportation work when the average ambient dose rates at workplaces are less than 2.5 μSv/h.

(Note): There is no need for exposure dose control when vehicles for commuting, transporting and doing business pass through the areas with the dose rate exceeding 2.5 μSv/h, because the times spent in those areas are limited and also entry is prohibited to the areas with the dose rate exceeding 9.5 μSv/h (workers would need to stay at the areas with the dose rate of 5 μSv/h for about 1,000 hours before the exposure doses exceed5 mSv/y. Even at the areas with the dose rate of 9.5 μSv/h, workers would need to stay about 520 hours over a year).

(2) Independent businessmen such as farmers and tradesmen find controlling exposure doses difficult. Therefore, it is desirable for them to avoid being engaged in works for handling designated contaminated soil and wastes or those under a designated dose rate by taking appropriate measures in advance such as decontaminating workplaces.

(Note): For those independent businessmen and tradesmen who assign works for handling designated contamination soil and wastes or works under a designated dose rate by necessity, these guidelines should be applied.

(Note): Volunteers should work at those places where the effective doses do not exceed 1 mSv/y and the average ambient dose rate is less than 2.5μSv/h (equivalent to 5 mSv/year calculated on the basis of 2,000 hours/y) with a work frequency of a few dozen times (days) per year.

(3) **The internal exposure doses indicated in (1)-a) above shall be measured as below.**

| | Highly radioactive soil and wastes(note 2) (over 500,000 Bq/kg) | Other than highly radioactive soil and wastes (less than 500,000 Bq/kg) |
|---|---|---|
| Work under high dust concentration(note 1) (over 10 mg/$m^3$) | Measurement of internal exposure once every three-month period | Screening test(note 3) |
| Work other than the above (less than 10 mg/$m^3$) | Screening test | Screening test(note3)(note4) |

(Note 1): The dust concentration in the air shall be deemed to exceed 10 mg/$m^3$ when removing soil, grinding/chipping the surfaces of asphalt/concrete, weeding, packing removed soil into bags and dismantling buildings and structures in dry conditions. When the dust concentration is measured during the work, it should be judged whether the work falls within the work under high dust concentration. The judgment method based on the measurement of dust should be the same as that specified in the Ionizing Radiation Ordinance for Decontamination.

(Note 2): The criteria for taking samples for the measurement of the radioactivity concentration of designated contamination soil and wastes shall be simpler than that for decontamination work. (See Annex 1 for details)

(Note 3): The concept of the measurement and the screening method for internal exposure shall be the same as those specified in the Ionizing Radiation Ordinance for Decontamination.

(Note 4): This measurement shall be implemented only when incidentally exposed to a high concentration of dust.

### 3. Exposure dose limit

(1) Employers shall ensure that the total effective dose received by workers as measured in 2-(1) – a) and b) should not exceed the limits listed in the following a) to c).

a) 100 mSv per five years and 50 mSv per year for male workers and female workers who have been clinically confirmed as having no capability of pregnancy.

b) 5 mSv per three months for female workers (excluding those who have been clinically confirmed as having no capability of pregnancy and those who fall under (c) below).

c) Effective dose of 1 mSv from internal exposure and equivalent dose of 2 mSv received on the abdominal surface of female workers who are confirmed as pregnant.

### 4. Records of the results of exposure doses

(1) Employers shall calculate and record radiation exposure doses received by their workers categorized in the following a) to c) below based on the measured results described in 2, and keep the records for 30 years. However, this does not necessarily apply when such records are transferred to an organization designated by the Minister of Health, Labour and Welfare after they have been kept for five years or the workers leave their jobs.

a) For male workers and female workers who have been clinically confirmed as having no capability of becoming pregnant: total effective doses every three months, one year and five-year periods (for those whose effective dose has never exceeded 20 mSv/y for a period of five years, total effective doses every three months and each year).

b) For female workers for whom it is clinically possible to become pregnant: total effective doses every month, three months and one year periods (for those who will not receive effective doses exceeding 1.7 mSv/month, total effective doses every three months and one year).

c) For pregnant female workers: total effective doses from internal exposure and equivalent doses received on their abdominal surface every month.

(2) Employers shall notify workers without delay of the records of the results of (1).

(3) Employers shall deliver the records of (1) to an organization designated by the Minister of Health, Labour and Welfare, if their business is terminated.

(4) Employers who assign works for handling designated contaminated soil and wastes or works under a designated dose rate shall issue a copy of the records if workers leave their jobs or their business is terminated.

## Section 4 Measures to Reduce Radiation Exposure of Workers

### 1. Preliminary examination

(1) When employers assign works for handling designated contaminated soil and wastes, they shall investigate the matters listed below in advance and record the results of the investigation. While continuously working in the same place, these matters shall be investigated once every two weeks.

a) Conditions of the workplaces

b) Average ambient dose rates at workplaces (μSv/h)(note 1)

c) Radioactivity concentration of contaminated soil and waste (Bq/kg)(note 2)

(Note): When the works are continued at the same workplaces, the average ambient dose rate and radioactivity concentration must be measured until the measured values are at a stable low level, unless they are clearly under 2.5 μSv/h and 10,000 Bq/kg respectively, since the measured values can vary even when the values are shown as less than 2.5 μSv/h and 10,000 Bq/kg.

(Note 1): The measurement of the ambient dose rate shall be conducted more simply than that for decontamination works. See Annex 2 for details.

(Note 2): The measurement method of the radioactivity concentration of contaminated soil and wastes shall be simpler than that for decontamination work. See Annex 1 for details. It should be noted that the radioactivity concentration of contaminated soil and wastes is measured in order to determine whether the concentration exceeds 10,000 Bq/kg or 500,000 Bq/kg. Therefore, when employers determine that the radioactivity concentration of the contaminated soil and waste to be handled exceeds 10,000 Bq/kg based on the estimate from the results of aircraft monitoring, etc. published by the Ministry of Education, Culture, Sports, Science and Technology in the area where the ambient dose rate is less than 2.5 μSv/h), such measurements of radioactivity concentration can be omitted.

(2) When employers assign works under a designated dose rate, they shall investigate the matters listed in advance and record the results of the investigations. While continuously working in the same place, these matters shall be investigated once every two weeks.

a) Average ambient dose rate at a workplace (μSv/h)

(Note): When the works are continued at the same workplaces, average ambient dose rates must be measured at certain intervals to prepare for changes in the rates. Even when the measured rate is less than 2.5 μSv/h,

the rates must be continuously measured until they are clearly below 2.5 μSv/h or they become stable at lower levels.

(Note): Since average ambient dose rates specified in this section (2) are measured in order to judge whether or not the rate exceeds 2.5 μSv/h, and radiation control is therefore required at individual workplaces, measurements at each workplace can be omitted when employers determine that the rates exceed 2.5 μSv/h based on the results of the aircraft monitoring published by the Ministry of Education, Culture, Sports, Science and Technology.

## 2. Formulation of the work plan and its works

(1) Employers assigning works for handling designated contaminated soil and wastes at areas where the average ambient dose rates exceed 2.5 μSv/h shall formulate a work plan in advance which accommodates the findings from their preliminary investigation and they shall proceed with their work according to the plan.

(2) The work plan includes the following:

a) Measurement method of the radiation exposure doses received by workers
b) Workplace
c) Types and capabilities of machines and tools to be used
d) Work methods
e) Measures to reduce radiation exposure
f) Emergency response measures in the event of an industrial accident

(3) The work methods include information about the following:

Personnel of workers, methods for using machines and tools, work procedures and work environment.

(4) The workplace includes the following:

a) Rest areas where eating, drinking or smoking is allowed (note 1)
b) Screening points (contamination monitoring areas where workers and their belonging are checked when they leave their workplace)(note 2)

(Note): In the works under a designated dose rate or those for handling designated contaminated soil and wastes in areas where the ambient dose rate is less than 2.5 μSv/h, workers are basically not expected to handle contaminated soil and wastes with radioactivity concentrations exceeding 500,000 Bq/kg which may cause internal exposures exceeding 1 mSv for those who inhaled the soil. Therefore, work plan will not be effective in reducing exposure dose, and thus for these situations, there is no need for formulating a work plan.

(Note 1): The criteria for setting rest areas for eating, drinking or smoking shall be the same as those specified in the Ionizing Radiation Ordinance for Decontamination.

(Note 2): The installation standards and the method of monitoring contamination shall be the same as those

specified in the Ionizing Radiation Ordinance for Decontamination.

(5) Measures to reduce radiation exposures include the following:

a) Measurement method of average ambient dose rate

b) Measures for reducing radiation exposure such as shortening work hours

c) Establishment of the target level for exposure doses based on the estimates of those doses

**3 Operation leaders**

(1) Employers assigning works for handling designated contaminated soil and wastes in the areas where the average ambient dose rate exceeds 2.5 μSv/h shall appoint operation leaders and assign the leaders the following responsibilities.

a) To determine work procedures and assignment of workers according to the work plan, and to lead the work directly.

b) To conduct meetings on the work procedures prior to the start of the work.

c) To check the machinery and equipment and eliminate defectives parts before starting the work.

d) To prohibit unauthorized personnel from entering the work areas.

e) To supervise the use of radiation detectors.

(2) Work procedures including the following.

a) Time management method of work

b) Work methods, workplaces and waiting places for each work procedure

**4 Submission of work notice**

(1) Employers (primary contractors) who receive an order directly from a contractee shall submit in advance a work notice for handling designated contaminated soil and wastes (note) to the relevant Labour Standards Inspection Office for works for handling designated contaminated soil and wastes for the work areas where the average ambient dose rate exceeds 2.5 μSv/h.

(Note): Work notices shall be in principle submitted by order. However, when orders involve works at multiple workplaces, work notices shall be submitted by workplace.

(2) The work notice for handling designated contaminated soil and wastes shall include the following:

a) Name of the operator (primary contractor)

b) Name of the contractee

c) Title of the work (name of the work order)

d) Workplace

e) Duration of the work

f) Name of the operation leader

g) A list of relevant subcontractors and the approximate number of workers

**5 Medical examinations by medical doctors**

Employers shall promptly provide medical examinations and treatment by medical doctors for workers engaged in works for handling designated contaminated soil and wastes or works under a designated dose rate in any of the following categories.

a) Workers who received an effective dose exceeding the exposure dose limit.

b) Workers who inhaled or ingested by mistake radioactive materials discharged by the nuclear power plant accident.

c) Workers who are not able to reduce their contamination level to less than 40 Bq/cm$^2$ by washing their bodies after they were contaminated with radioactive materials discharged by the nuclear power plant accident.

d) Workers having open wounds that become contaminated by radioactive materials discharged by the nuclear power plant accident.

(Note): Regarding b) above, cases are limited to when a certain amount of internal exposure is expected including when workers are buried in a large amount of earth and sand due to a workplace accident and the results of their nasal smear tests show a contamination level over the criterion, or a large amount of earth, sand or contaminated water was ingested.

# Section 5 Measures for Preventing the Spread of Contamination and Internal Exposure of Workers

**1. Prevention of the spread of contamination (note)**

(1) It is advisable that employers who assign works for handling designated contaminated soil and wastes remove contaminated soil and waste with high radioactivity concentration as much as possible from the workplaces in advance, except in cases where they assign works whose dose lowering effect is equal to or greater than the effect gained from the removal of contaminated soil and waste such as soil capping, paving, and turning over and plowing. However, this provision does not apply to works to recover the infrastructures required for decontamination work such as those for restoring water and electricity supplies and roads.

(2) When employers are assigning works for handling designated contaminated soil and wastes involving collection, transportation and storing of contaminated soil for which radioactivity concentration exceeds 10,000 Bq/kg (herein after referred to as “designated contaminated soil and wastes”), they shall use specially dedicated containers and implement necessary measures to avoid the dispersal and leaking of the soil from the containers while the soil is stored. However,

this provision does not apply when effective measures are taken for soil and wastes that are extremely difficult to store in containers, such as providing external radiation shielding, or preventing the contamination from spreading.

(Note): The "collection, transportation and storing of contaminated soil and wastes" specified here means that construction workers etc. transport and temporarily store contaminated soil originating from the excavation near their workplaces (soil not intended to be removed) on a temporary basis as a part of work to prepare infrastructures for daily life. When they collect removed soil (soil intended to be removed from the workplace), their work falls under the "work for collecting waste, etc." as specified in the existing Ionizing Radiation Ordinance for Decontamination.

(Note): Storing excavated contaminated soil temporarily for a short period of time until the soil is re-buried is not considered to fall under "storing".

(Note): "Materials that are extremely difficult to store" include large-sized machines, felled trees larger than containers, materials from dismantling structures, and significantly large amounts of contaminated soil. As they need be divided into smaller sizes to fit into the containers, exposure to high external radiation and dust are expected from those works.

(Note): "Effective measures to shield the external radiation or prevent the contamination from spreading" includes covering contaminated soil with water-impermeable sheets.

a) Containers used for collection or storing designated contaminated soil and wastes.
Containers shall be free from a risk of dispersal or leaking of designated contaminated soil and wastes.

b) Containers used for the transportation of designated contaminated soil and wastes.

・ Containers shall be free from a risk of dispersal or leaking of designated contaminated soil and wastes.

・ The exposure dose rate (1-cm dose equivalent) at one meter from the surface of a container (when a container is wrapped, the surface of the wrapping) shall not exceed 0.1 mSv/h.
In the case of transporting a container by a loading vehicle only, however, if the maximum dose rate (1-cm equivalent dose rate) at the distance of 1 meter from the front, rear and both sides of the vehicle (or from the outermost tire surface in the case the vehicle is an open type) does not exceed 0.1 mSv/h, the provision mentioned above does not apply.

(3) Employers shall carry out the following actions when they temporarily store contaminated soil.

a) Take necessary measures to prevent dispersal and leakage of designated contaminated soil and wastes.

b) Clearly post signage indicating that designated contaminated soil and wastes are stored here.

c) Take measures to prohibit unauthorized people from entering by installing fences.

(Note): No specific measurements are necessary for work to wet soil because, unlike decontamination work, this is not aimed at removal of the soil and the areas for the work may be significantly larger than those for decontamination work.

**2. Prevention of spread of contamination by workers**

(1) Employers who assign works for handling designated contaminated soil and wastes shall establish contamination monitoring areas[(note 1)] near the workplaces to prevent the spread of contamination by workers, and to monitor the contamination of workers and their equipment when they leave their workplaces.

(2) When workers are found to be contaminated at a level greater than the contamination limit [(note 2)], they shall not be allowed to leave their workplaces until the following measures are taken.

a) When personal contamination is found, the body of the person should be washed until the contamination level becomes lower than the limit.

b) When equipment worn by workers is found to be contaminated, it should be taken off or otherwise removed.

(Note): The radioactivity concentration of soil in farmland (average concentration down to 15 cm below the surface of the ground) can be estimated based on the ambient dose rate at one meter height from the surface of the ground; when the ambient dose rate is less than 2.5 μmSv/h, the radioactivity concentration of soil is estimated to be less than 10,000 Bq/kg (average concentration down to 15 cm below the surface of the ground). The same estimate is possible for the layer of deciduous leaves and the soil in forests. Therefore, when handling the layer of deciduous leaves on farmland and forests, the measurement of surface contamination can be basically omitted.

However, there are data indicating that 50 % (for farmland before plowing) or 60 % (for school playgrounds) of the radioactive materials are concentrated within one centimeter below the ground surface, and they are concentrated in the deciduous leaf layer in forests. The radioactivity concentration in soil near the surface and in the deciduous leaf layer may be significantly higher than preliminary calculations. Therefore, measurement of surface contamination is required for works handling the soil near the surface of farmland before plowing only or those handling the deciduous leaf layer and soil near the surface of the ground only.

(Note): For contaminated soil in living environments (around buildings, structures, roads, etc.) the radioactivity concentration of contaminated soil and wastes (Bq/kg; average value down to 5 cm from the ground surface) can be estimated on certain assumptions from the results of aircraft monitoring for the deposited radioactive materials ($Bq/cm^2$) on the ground surface. However, for living environments, because of variations in buildings, structures, roads and rivers, it would not be appropriate to apply an estimated result uniformly; it would not reflect the reality. In addition, specific restoration work for the infrastructure in

living environments will also vary. Careful consideration should be given to omitting measurement of surface contamination and relying on uniform estimates.

For works conducted in areas where measures have been taken in advance such as removing the surface soil, it is necessary to examine if the measurement of surface contamination can be omitted when the estimated value from the deposition of radioactive materials onto the ground surface (Bq/cm$^2$) is less than 10,000 Bq/kg.

(Note 1): Contamination monitoring areas shall be set as follows:

a) Employers shall set contamination monitoring areas in or near workplaces. In principle, the monitoring areas should be located on the border between the contracted and non-contracted areas for decontamination work. When this is not possible due to the topography of the site, monitoring areas shall be set near the border.

b) Regardless of the above, when a single employer has a contract for decontamination work at multiple work areas, and when workers move by an enclosed vehicle and measures to prevent the spread of the contamination by contaminated workers and items are taken, a comprehensive contamination monitoring area serving multiple workplaces can be set at a place chosen by the employer on a discretionary basis. This applies also for cases when a multiple number of employers collectively set such a monitoring area or when a contractee provides the monitoring area for their contractors.

(Note 2): The contamination limit shall be 40 Bq/cm$^2$ (13,000 cpm with a GM counter).

(3) Employers shall set contamination monitoring areas near the workplaces for works for handling designated contaminated soil and wastes, and monitor the contamination of items removed from the workplace. This does not apply for cases where measures to prevent the spread of contamination have been taken such as items are put into a container before being transported to other workplaces for works for handling designated contaminated soil and wastes.

(4) At a contamination monitoring area (note 3), when items are found to be contaminated over the limit (note 4), they should not be removed from that workplace. However, this does not apply in the case where measures to prevent the spread of the contamination have been taken such as items are encased in containers before being transported to decontamination facilities, storing or disposal facilities for contaminated soil or other workplaces for works for handling designated contaminated soil and wastes.

(Note 3): With regard to vehicles, contamination should be inspected considering the following points after washing off contaminated soil and wastes attached to vehicles:

- There is no need for monitoring contamination of items that can touch the ground such as vehicle tires. Items like tires can be recontaminated on the road even after they have been decontaminated at the monitoring area and their contamination level lowered below the contamination limit.

- Decontamination measures are necessary for parts of vehicles other than tires such as the interior and the loading platform of the vehicle where contamination levels are greater than the limit.
- It is advisable that trucks which are used for transporting items with contamination greater than the limit are inspected for contamination and decontaminated at the place where those items are unloaded. If this is not possible, measures should be taken to prevent the dispersal and leakage of removed soil from the loading platform of the vehicle by wrapping the platform with plastic sheets and then returning to a decontamination monitoring area for rechecking and decontamination.

(Note 4): The contamination limit shall be 40 Bq/cm$^2$ (13,000 cpm with a GM counter)

(5) Employers shall take the effective measures as listed below to prevent workers' bodies, belongings and other items from being contaminated above the limit during works for handling designated contaminated soil and wastes.
   a) Changing and disposal of shoes, clothing and gloves, and changing and disposal of protective clothing
   b) Treatment of machines and devices before use and their decontamination after use
   c) Treatment of designated contaminated soil and wastes during transportation
   d) Maintaining cleanliness at workplaces

**3. Prevention of body surface contamination and internal exposure**

(1) Employers shall provide effective respiratory protective equipment such as dust masks for workers engaged in works for handling designated contaminated soil and wastes, according to the work classification shown below and the radioactivity concentration of the soil to be handled. Workers shall wear effective respiratory protective equipment during works for handling designated contaminated soil and wastes.

| | Highly contaminated soil and wastes (> 500,000 Bq/kg) | Other than highly contaminated soil and wastes (≤ 500,000 Bq/kg) |
|---|---|---|
| Work under high dust concentration (over 10mg/m$^3$) | Dust collection efficiency ≥ 95%(Note 1) | Dust collection efficiency ≥ 80% |
| Work other than the above | Dust collection efficiency ≥ 80% | Dust collection efficiency ≥ 80%(Note 2) |

(Note 1): The selection criteria for dust collection efficiency for dust masks is the same as that specified in the Ionizing Radiation Ordinance for Decontamination.

(Note 2): For work (with exposure to non-mineral dust) not applicable under Article 27 of the Ordinance on

Prevention of Hazards due to Dust (MHLW Ordinance no. 18, 1979 for the use of respirators), non-woven material masks are sufficient for protection. (These are other than dust masks which need to pass the national standard test. Non-woven material masks are commonly used for protection from colds and pollen allergy symptoms. They are called surgical, pleated or face masks. Those made of gauze material are not included.)

(Note): The selection of dust masks should be based on appropriateness for the work. It is not advisable to use masks with excessive dust collection efficiency as they may hinder work efficiency and may be inappropriate.

(2) Employers assigning workers for handling designated contaminated soil and wastes at areas where the contamination level may be greater than the limit shall prepare effective protective clothing, gloves and shoes and provide them to workers, according to the work classification and the level of radioactivity concentration in the soil shown in the table below. Workers shall wear effective protective clothing during the work.

| | Highly contaminated soil and wastes (≥ 500,000 Bq/kg) | Other than highly contaminated soil and wastes (< than 500,000 Bq/kg) |
|---|---|---|
| Work under high dust concentration (over 10mg/$m^3$) | Tyvek suits, rubber gloves (worn over cotton gloves), rubber boots | Long-sleeve shirts, cotton gloves, rubber boots |
| Work other than the above (less than 10mg/$m^3$) | Long-sleeve shirts, rubber gloves (worn over cotton gloves), rubber boots | Long-sleeve shirts, cotton gloves, rubber boots |

(Note): The selection criteria of protective clothing are the same as those specified in the Ionizing Radiation Ordinance for Decontamination.

(3) Employers shall not provide protective gear and clothing to workers when those items are contaminated; the contamination level should be brought below the limit by washing them in advance.

**4. Employers assigning works for handling designated contaminated soil and wastes shall** prohibit workers from smoking, eating or drinking in the workplaces where they could inhale or ingest contaminated soil. Workers shall refrain from those actions.

## Section 6 Education for Workers

### 1. Education for operation leaders

(1) Employers shall appoint workers who lead operations for handling designated contaminated soil and wastes and provide them with education regarding the following subjects:

a) Determining work procedures and assigning the decontamination workers to them

b) Directing decontamination workers at the workplace

c) Taking suitable measures in the case of abnormal events

(2) See Annex 3 for details in implementing the education

**2. Special education for workers engaged in handling designated contaminated soil and wastes**

(1) Employers who assign workers to works for handling designated contaminated soil and wastes shall provide them with special education through lectures and practical training in the following subjects.

a) Lectures for special education

(i) Knowledge about effects of ionizing radiation on living organisms and the methods of controlling exposure doses

(ii) Knowledge about the work methods for handling designated contaminated soil and wastes

(iii) Knowledge about the structure, handling and use of the machines for works for handling designated contaminated soil and wastes

(iv) Knowledge about relevant laws and regulations

b) Practical training

The work methods for handling designated contaminated soil and wastes and handling and use of machines for the work

(Note): The training hours and the contents of the subjects are basically the same as those specified in the Ionizing Radiation Ordinance for Decontamination.

**3. Special education for workers under a designated dose rate**

(1) Employers assigning workers to engage in works under a designated dose rate shall provide them with special education through lectures and practical training in the following subjects.

(i) Knowledge about effects of ionizing radiation on living organisms and the methods of controlling exposure doses

(ii) Knowledge about the methods of measuring ionizing radiation

(iii) Knowledge about the relevant laws and regulations

(Note): Workers under a designated dose rate will be exposed only to radiation in the air, not to radiation from their work, and therefore inspection of contamination is not required. Thus education related to work methods and contamination checks as well as practical training is excluded from the special education specified in the Ionizing Radiation Ordinance.

**4. Other necessary training**

(1) It is advisable that similar training shall be provided to self-employed workers such as farmers.

(2) It is advisable that those who contract out works for handling designated contaminated soil and wastes confirm whether the contractor has established an organizational system to secure the

necessary number of properly educated work leaders and workers to implement the work by the time they commence it.

## Section 7 Measures for Medical Care of Workers

**1. Special medical examinations**

(1) Employers shall provide medical examinations by medical doctors to workers who are regularly engaged in works for handling designated contaminated soil and wastes in the areas where the average ambient dose rate exceeds 2.5 μSv/h; the examinations shall be given at the time of employment or being transferred to the work, and once within every six months thereafter on a regular basis, regarding the following items:

a) Inquiry of exposure history and its evaluation
b) White blood cell count and differential leukocyte count
c) Red blood cell count, hemoglobin or hematocrit levels
d) Eye examination for cataracts
e) Dermatological examination

Regardless of (1) above, medical examinations are not necessary for workers whose effective doses in the previous year did not exceed 5 mSv/y at their regular medical examination, and for those in the current year that are unlikely to exceed 5 mSv/y, examinations b)-e) above can be omitted, when a medical doctor considers so.

(Note): In the Ionizing Radiation Ordinance, examinations b)-e) above can be partly or fully omitted when a medical doctor determines that these examinations are unnecessary, regardless of exposure doses. This is because (a) exposure doses of radiation workers have significantly decreased in recent years and (b) even under the planned exposure situation, the exposure dose can be controlled by appropriately controlling the radiation sources. However, in the Ionizing Radiation Ordinance for Decontamination, omission of medical examination items is limited to workers whose exposure doses are less than 5 mSv/y. This is because, in the current circumstances covered by the Ordinance, (a) radiation control by work planning is difficult as radiation sources are dispersed and (b) decontamination work under high ambient dose rate areas are expected and it is difficult to assume the exposure doses during the decontamination in the future.

(2) When omitting medical examination items as described in (2) above, workers shall receive medical examinations on items which are the same as those in the general medical examinations once every six months.

(3) Employers shall prepare medical examination cards based on the results of the medical examinations and keep them for 30 years. However, this does not apply when the cards are

transferred to an organization designated by the Minister of Health, Labour and Welfare after being kept for five years.

(4) When employers terminate their business, they shall transfer the records in (4) above to an organization designated by the Minister of Health, Labor and Welfare.

(5) When workers engaged in works for handling designated contaminated soil and wastes or those under a designated dose rate leave their jobs, or when employers terminate their business, copies of the records in (4) above shall be issued to the relevant workers.

(Note): The special ionizing radiation medical examination is intended to be conducted for workers who are regularly engaged in work with the exposure doses expected to exceed 5 mSv/y. Ongoing work such as manufacturing is not permitted in the areas where the ambient dose rate exceeds 3.8 μSv/h (presumed to be 40% of the level; 1.4μSv/h, indoors) unless the work is a special case. Workers are not expected to regularly work in the areas where the ambient dose rate exceeds 2.5 μSv/h for six months, other than when engaged in works for handling designated contaminated soil and wastes. Therefore, the special ionizing radiation medical examination shall be provided only to workers engaged in handling designated contaminated soil and wastes in the areas with the ambient dose rate greater than 2.5 μSv/h.

**2. General medical examinations**

(1) Employers shall provide medical examinations by medical doctors to workers who are regularly engaged in works for handling designated contaminated soil and wastes in the areas where the average ambient dose rate exceeds 2.5 μSv/h at the time of employment or of being transferred to the work, and once within every six months thereafter on a regular basis.

<Examination items are the same as those in the general medical examinations of ordinary workers.>

(2) Employers shall provide medical examinations by medical doctors to workers who are engaged in works for handling designated contaminated soil and wastes or those under a designated dose rate in areas where the average ambient dose rate is less than 2.5 μSv/h at the time of employment or of being transferred to the work, and once within every one year thereafter on a regular basis.

<Examination items are the same as those in the general medical examinations of ordinary workers.>

(3) Omission criteria of checked items in the medical examinations (Article 45, Ordinance on Industrial Safety and Health)

(4) Preparation of medical examination cards and their preservation for five years (Article 51, Ordinance on Industrial Safety and Health)

**3. Actions after the medical examinations**

(1) Workers receive the advice of a medical doctor on the results of their medical examinations (the same as provided in the Ionizing Radiation Ordinance).

(2) Workers receive written notification of the medical examination results (the same as provided in the Ionizing Radiation Ordinance).

(3) Employers prepare and keep cards based on medical examination results (the same as provided in the Ionizing Radiation Ordinance).

(4) Measures may be taken based on the medical examination results, etc. (the same as provided in the Ionizing Radiation Ordinance).

## Section 8 Safety and Health Management System

**1. Establishment of the safety and health management system by primary contractors**

(1) Appointment of a general safety and health manager

The primary contractor engaging in works for handling designated contaminated soil and wastes shall appoint a general safety and health manager from among their workers who supervise works for handling designated contaminated soil and wastes in order to ensure appropriate management of safety and health and the contractor shall give the manager responsibility for the following actions (2) to (4).

(2) Appointment of personnel responsible for managing the safety and health in relevant subcontractors

The relevant subcontractors shall be allowed to choose personnel responsible for the management of their safety and health and also the following items.

a) Communicate with the general safety and health manager of the primary contractor.

b) Coordinate with the general safety and health manager of the primary contractor to implement matters applicable to relevant subcontractors in a smooth way with regards to the matters listed below.

c) Communicate and coordinate with all the relevant parties, when the relevant subcontractors contract out part of their work to other subcontractors.

(3) Holding safety and health coordination meetings consisting of all relevant contractors

a) An organization for coordinating safety and health consisting of all relevant contractors shall be established and meetings shall be held once every month on a regular basis.

b) Issues to be discussed at the safety and health coordination meetings include the following.

i) Safety and health education such as special education required for workers who are newly

engaged in works for handling designated contaminated soil and wastes.

ii) Implementing preliminary surveys, and preparing and improving work plans.

iii) Setting contamination monitoring areas and implementing the monitoring.

iv) Implementing emergency communications and setting actions to be taken in the event of an industrial accident.

(4) Guidance and support for the preparation of work plans

a) Guide and support relevant subcontractors in conducting preliminary surveys properly and preparing appropriate work plans.

b) Guide and support relevant subcontractors on the notification of preliminary survey results and the contents of work plans to their workers.

(Note): Workers at works under a designated dose rate do not handle contaminated soil and wastes. Therefore, actions such as preparation of a work plan and contamination monitoring are not required, and the necessity for communication and coordination with subcontractors is minimal. The requirement for communication and coordination with subcontractors shall be limited to works for handling designated contaminated soil and wastes.

**2. Consolidated management by primary contractors of radiation exposure**

(1) Primary contractors who assign works for handling designated contaminated soil and wastes or works under a designated dose rate shall appoint a radiation administrator to take responsibility for consolidated management including the control of radiation exposure to workers who are employed by relevant subcontractors. It is desirable that the radiation administrator is appointed from the group of employees who have radiation related qualifications approved by the Japanese government and have attended training courses on radiation management provided by specialized education institutions.

(2) Under the supervision of the safety and health manager, primary contractors engaging in works for handling designated contaminated soil and wastes shall give the radiation administrators responsibility for the following matters in addition to (1) above.

a) Set contamination monitoring areas and implement contamination monitoring in the appropriate manner based on discussions with their contractees.

b) Guide and support the radiation administrators of subcontractors for appropriate implementation of measures as specified in Section 3, items 2 to 4.

c) Implement other necessary matters relating to radiation control.

(Note): Workers engaged in works under a designated dose rate do not handle contaminated soil and wastes and actions such as preparation of a work plan and contamination monitoring are not required.

Therefore radiation administrators are only responsible for the consolidated control of radiation. The work specified in (2) is only applicable for works for handling designated contaminated soil and wastes.

**3. Safety and health management system**

(1) Employers who assign works for handling designated contaminated soil and wastes or works under a designated dose rate shall appoint health managers or safety and health managers depending on the sizes of their operations. These appointees shall be responsible for managing technical aspects of the works such as measuring exposure doses and recording the measured results. Also, the appointees from employers assigning works for handling designated contaminated soil and wastes shall be responsible for managing technical aspects of measures for contamination monitoring, prevention of personal contamination and internal exposure, education, and medical examinations for workers.

It is desirable to appoint a safety and health manager even in the workplaces where the number of workers is less than 10.

**(2)** Employers who assign works for handling designated contaminated soil and wastes or works under a designated dose rate shall appoint radiation administrators who will be responsible for managing radiation, regardless of the sizes of their operations. The radiation administrators shall measure exposure doses and record the results of the measurements. Such appointees from employers assigning works for handling designated contaminated soil and wastes shall be responsible for monitoring workers for contamination and protect workers from body contamination and internal exposure.

## IV References (omitted here)

1. A distribution map of radioactive material concentrations in farmland soil collected in Fukushima Prefecture and municipalities (reference for the 8th expert review meeting).
2. Measurement results of radioactive cesium concentrations in forests (reference for the 8th expert review meeting).
3. Sampling method for collecting soil to measure radioactivity concentrations (Reference for the 8th expert review meeting).
4. Sampling method for collecting soil in forests as proposed by the Forest Products Research Institute (Reference for the 8th expert review meeting).
5. Distribution of radioactivity concentrations in sea water (from the website of the Ministry of Education, Culture, Sports, Science and Technology) (Reference for the 10th expert review meeting).
6. Distribution of radioactivity concentrations on the sea floor (an excerpt from the website of the Ministry of Education, Culture, Sports, Science and Technology) (Reference for the 10th expert review meeting).
7. Report on the decontamination demonstration project (excerpt) (Reference for the 10th expert review meeting).
8. Simplified calculation method of radioactive cesium concentration in agricultural soil (Reference for the 10th expert review meeting).
9. Estimate of radioactive cesium concentrations in agricultural soil (Reference for the 10th expert review meeting).
10. Specifications of currently available industrial dust masks, surgical masks and masks for domestic use in Japan (Reference for the 10th expert review meeting).

**Annex 1. Measurement method of radioactivity concentration in contaminated soil and wastes**

**1. Purpose**

The purpose of the measurement of the radioactivity concentration in soil and wastes is to help employers determine whether the contaminated soil etc. exceeds the reference value (10,000 Bq/kg or 500,000 Bq/kg) and then to decide necessary radiation protection measures in assigning works for handling designated contaminated soil and wastes.

**2. Principles**

(1) Radioactivity concentration shall be measured prior to commencing the work.

(2) When continuing work at the same workplace, measurement of the concentration of radioactive materials shall be conducted once every two weeks. The measurement should be continued even when the concentration level becomes lower than 10,000 Bq/kg in order to be prepared for any fluctuation of measured values until such time that the measured values are stabilized at low levels significantly below 10,000 Bq/kg.

(3) It is desirable that the measurement be commissioned to experts.

(4) The radioactivity concentration shall be measured for soil and waste to be actually handled in the work.

(5) The highest value among measurements shall be selected as a representative one considering the large variability in radioactivity concentration measurements.

**3. Sampling**

(1) Principles for sampling

a) Either one of the following materials shall be sampled.

(i) Contaminated soil, removed soil or contaminated waste in the area where the highest ambient dose rate was observed among ambient dose measurement points

(ii) Contaminated soil and waste to be handled that is expected to have highest radioactivity concentration

b) Several materials shall be sampled from each workplace (every 1000 $m^2$ when the size of the workplace is larger than 1000 $m^2$). For the workplace whose size is significantly larger than 1000 $m^2$ and where radioactivity concentrations are relatively consistent for farmland, contaminated soil and waste, the number of materials to be sampled may be considered as at least one for every 1000 $m^2$.

c) When soil and wastes are excavated to a certain depth, the sample will allow representation of the average concentration of the excavated soil and wastes.

(Note): The unit area of the sampling, "1,000 $m^2$", was determined as approximately 10 times that of

indoors for which measurement is conducted every 70 $m^2$.

(2) Locations of sampling

Soil and wastes with high radioactivity concentrations are expected in the following places.

a) Farmland

Soil in the zone up to about 15 cm in depth from the surface

b) Forests

Among leaves, tree barks, fallen leaves and branches, those that are expected to have the highest radioactivity concentration are sampled (when measuring leaf mold, soil in the zone up to 15 cm in depth including the mold and soil under the mold)

c) Living environment (Areas around structures such as buildings and roads)

For soil handled in the work, soil in the area where rain water is collected and where collected rain water runs off, soil on plants and their roots, soil in locations where rainwater, mud or soil tend to be accumulated, and soil of removed objects such as sludge near the structures to which small particles tend to be attached are sampled. (This means soil in the zone from the surface to the depth where actual decontamination occurs. The depth shall vary depending on the excavation depth in the actual decontamination works.)

**4. Analysis method**

Either method below shall be used for analysis.

(1) The total gamma ray measurement or gamma spectrum analysis, as specified in Article 9, Paragraph 1-2 of the Working Environment Measurement Standards.

(2) Simplified measurement method

a. The radioactivity concentration shall be calculated using the following method if the correlation between the dose rate on the sample surface and the sum of the concentrations of Cs-134 and Cs-137 is known. (See Annex 1-1 for details.)

(i) Place the sample in a container and measure the weight.

(ii) Measure the maximum dose rate on the surface of the container.

(iii) Use the measured weight and the dose rate to calculate the sum of the concentrations of Cs-134 and Cs-137 of the sample.

b. It is difficult to measure radioactivity concentration equal to 300,000 Bq/kg or more with the simplified method even when using the V5-type container because the upper measurement limit of the typical NaI scintillation counter is as low as 30 μSv/h. Therefore, when the pointer on the scintillation counter goes past 30 μSv/h, the relevant regulations shall be applied under the assumption that the concentration of the measured object exceeds 500,000 Bq/kg, or an analysis shall be carried out using the method of (1) above.

(3) Simplified measurements based on the relationship between ambient dose rates and radioactivity concentration

a. The radioactivity concentration (an average value in the zone up to 15 cm in depth) of farmland can be calculated from the ambient dose rate (a detailed method is under review). A similar estimate is also possible for the layer of fallen leaves in forests (a detailed method is under review). Therefore, for soil in farmland and for layers of fallen leaves in forests, simplified measurements and calculations based on the ambient dose rates are acceptable.

However, there are data indicating that 50 % of radioactive materials (for farmland before plowing) or 60 % of radioactive materials (for school playgrounds) are concentrated within one centimeter below the ground surface, and they are concentrated in the deciduous leaf layer in forests. The radioactivity concentration in soil near the surface and in the deciduous leaf layer may be significantly higher than preliminary calculations. Therefore, the simplified measurements shown above shall not be applied to works handling the soil near the surface of farmland before plowing only or those handling deciduous leaf layers and soil near the surface of the ground only.

b. For contaminated soil in the living environments (around buildings, structures, roads, etc.) the radioactivity concentration of contaminated soil and wastes (Bq/kg; average value down to 5 cm from the ground surface) can be estimated on certain assumptions from the results of aircraft monitoring for the deposited radioactive materials (Bq/cm2) on the ground surface. However, for living environments, because of variations in buildings, structures, roads and rivers, it would not appropriate to apply estimated result uniformly; it would not reflect the reality. In addition, specific restoration work for the infrastructure in living environments will also vary. Careful consideration should be given to omitting measurement of surface contamination and relying on uniform estimates.

For works restoring infrastructure in living environments where decontamination actions have been taken such as removing the surface soil, it is necessary to examine applicability of the simplified measurement because the estimated value may represent the actual concentration.

**Annex 1-1 Simplified measurement procedures for radioactivity concentration**

1. Method to determine that the radioactivity of contaminated soil and waste in the round V-series Container (plastic jar 128 mm diameter x 56 mm height, hereinafter referred to as the "V5 Container") is lower than 10,000 Bq/kg or lower than 500,000 Bq/kg

   The following is the method for determining whether the radioactivity concentration of the V5 container containing contaminated soil and waste is lower than 10,000 Bq/kg or lower than 500,000 Bq/kg.

   1) Measure the radiation dose rate on the surfaces of the V5 container containing contaminated soil and waste, and define the largest value as *A* (μSv/h).
   2) Determine the radioactivity *B* (Bq) of the V5 containers containing contaminated soil and waste by putting the factor *X* depending on the measurement date and the measured radiation dose rate *A* (μSv/h) in the following formula. Table 1 lists the values of the factor *X* by measurement date and container type.

      *A* x Factor *X* = *B*
   3) Measure the weight of the V5 container containing contaminated soil and waste. This is set as *C* (kg).
   4) To determine the radioactivity concentration *D* (Bq) of the containers containing contaminated soil and waste, substitute the radioactivity of the V5 containers containing contaminated soil and waste for *B* (Bq) and the weight for *C* (kg) in the following formula.

      *B* / *C* = *D*

   Thus, it can be determined whether the radioactivity concentration D of the V5 container containing contaminated soil and waste is lower than 10,000 Bq/kg or lower than 500,000 Bq/kg.

2. Method to determine that the radioactivity in the sandbag is lower than 10,000 Bq/kg

The following is the procedures for determining whether the radioactivity concentration of a sandbag containing contaminated soil and waste (contaminated soil, removed soil or contaminated waste are hereafter referred to as the same) is lower than 10,000 Bq/kg.

1) Measure the radiation dose rate on the surfaces of the sandbag containing contaminated soil and waste, and define the largest value as *A* (μSv/h).
2) Determine the radioactivity *B* (Bq) of the sandbag containing contaminated soil and waste by putting the factor *X* depending on the measurement date and the measured radiation dose rate *A* (μSv/h) in the following formula. Table 1 lists the values of factor *X* by measurement date and container type.

*A* x Factor *X* = *B*

3) Measure the weight of the sandbag containing contaminated soil and waste. This is set as *C* (kg).
4) To determine the radioactivity concentration *D* (Bq) of the sandbag containing contaminated soil and waste, substitute the radioactivity of the sandbag containing contaminated soil and waste for *B* (Bq) and the weight for *C* (kg) in the following formula.

*B* / *C* = *D*

Thus, it can be determined whether the radioactivity concentration D of the sandbags containing contaminated soil and waste is lower than 10,000 Bq/kg.

Table 1 Values of the factor *X* listed by the measurement date and container types

| Measurement date | Values of factor X | |
|---|---|---|
| | V5 Container | Sandbag |
| Until January 2012 | 3.0E+04 | 6.8E+05 |
| Until April 2012 | 3.1E+04 | 7.0E+05 |
| Until July 2012 | 3.1E+04 | 7.1E+05 |
| Until October 2012 | 3.2E+04 | 7.2E+05 |
| Until January 2013 | 3.3E+04 | 7.4E+05 |
| Until April 2013 | 3.3E+04 | 7.5E+05 |
| Until July 2013 | 3.4E+04 | 7.6E+05 |
| Until October 2013 | 3.4E+04 | 7.8E+05 |
| Until January 2014 | 3.5E+04 | 7.9E+05 |
| Until April 2014 | 3.6E+04 | 8.1E+05 |
| Until July 2014 | 3.6E+04 | 8.2E+05 |
| Until October 2014 | 3.7E+04 | 8.3E+05 |
| Until January 2015 | 3.8E+04 | 8.5E+05 |

**Annex 2 Methods of measurement and evaluation of the average ambient dose rate**

1 Objectives

The purpose of measurement and evaluation of average ambient dose rate is for employers assigning workers to works for handling designated contaminated soil and wastes or those under a designated dose rate to measure and evaluate whether or not the dose rate at a workplace exceeds 2.5 μSV/h, and accordingly to determine measured to control radiation exposures that can be implemented when employers assign workers to the works.

2. Principles

(1) Radioactivity concentration shall be measured prior to commencing the work.

(2) When continuing work at the same workplace, measurement of the concentration of radioactive materials shall be conducted once every two weeks. The measurement should be continued even when the concentration level becomes lower than 10,000 Bq/kg in order to be prepared for any fluctuation of measured values until such time that the measured values are stabilized at low levels significantly below 10,000 Bq/kg.

(3) The dose rate shall be measured to appropriately reflect the actual exposure conditions of workers.

3. Measurement and evaluation of the average ambient dose rate

(1) General items

a) The average ambient dose rate shall be measured at a point one meter above the ground surface.

b) The measuring device shall comply with Article 8 of the Working Environmental Measurement Standards.

(2) When the variation of the ambient dose rates is expected to be small

When the variation of the ambient dose rates is expected to be small during works under a designated dose rate or works for handling designated contaminated soil and wastes, the average ambient dose rate shall be measured at a few points where the exposure dose is likely to be the highest in the work area and the average of those measured rates shall be determined to be the final average ambient dose rate of the workplace (when the area of a workplace is over 1,000 m2, the total area is subdivided into sub-areas, the size of each being less than 1,000 m2, for measurement).

(Note): When decontamination work has been implemented and contaminated soil and wastes with high radioactivity were removed in advance of the present work, the ambient dose rate is basically considered as the area with a small ambient dose rate variation even in the areas for works for handling designated contaminated

soil and wastes.

(3) When the variation of the ambient dose rates is expected to be large

a) Average dose rate during works for handling designated contaminated soil and wastes shall be calculated according to the formula shown below regardless of the provision in (2) when radioactive materials are concentrated at a certain place of the work area resulting in a significant difference in the ambient dose rate from that in other work areas.

b) The following matters should be noted.

i) Ambient dose rate shall be measured at several points every 1000 $m^2$ around the points where higher dose rate is expected (hereafter referred to as the "specified measuring point").

ii) Exposure dose shall be calculated for a representative individual for whom the highest dose is expected.

iii) When the work continues several days at the same place, the calculation shall be conducted assuming the day when the work with the highest exposure dose was done.

$$R = \left( \sum_{i=1}^{n} \left( B^{i} \times \mathrm{WH}^{i} \right) + \mathrm{A} \times \left( \mathrm{WH} - \sum_{i=1}^{n} \left( \mathrm{WH}^{i} \right) \right) \right) \div \mathrm{WH}$$

*R*: average ambient dose rate ( $\mu$ Sv/h)

*n*: number of specified measuring points

*A*: average ambient dose rate (rSv/h) calculated according to (2)

*B*i: ambient dose rate values at each specified measuring point (oSv/h). To be put in the formula to obtain R

*WH*$^{i}$: working hours (h) at the place of concern of a worker whose exposure dose is expected to be the highest among decontamination workers engaged in decontamination works at the place near each specified measuring point

*WH*: working hours (h) in a day of the selected decontamination worker

**Annex 3. Special education for workers**

1. Special educational lectures and practical training shall be provided to workers who handle designated contaminated soil and wastes.

The special education shall be provided by the lectures of the table below. General subject areas are in the left column, specific topics are in the middle column and the minimum time to be allotted is in the right column.

| Subject areas | Specific topics | Minimum duration |
|---|---|---|
| Knowledge about effects of ionizing radiation on a living body and exposure dose control methods | 1) Types and nature of ionizing radiations<br>2) Effects of ionizing radiation on cells, tissues, organs and the whole body<br>3) Exposure dose limit and methods of measuring doses<br>4) Method for confirming and recording results of dose measurements | 1 hour |
| Knowledge about the methods for works for handling designated contaminated soil and wastes | 1) Methods and procedures of works for decontaminating soil and wastes.<br>2) Methods for measuring radiation<br>3) Methods for monitoring equivalent dose rate from external radiation<br>4) Methods for preventing contamination from spreading<br>5) Methods for inspection of the contamination on the body surface and for decontamination<br>6) Function and use of protective equipment<br>7) Emergency measures in case of abnormal events | 1 hour |
| Knowledge about the structure and handling of machinery used for works for handling designated contaminated soil and wastes | The structure and handling of machinery used for works for handling designated contaminated soil and wastes | 1 hour |
| Relevant laws and regulations | Applicable provisions in the Industrial Safety and Health Act, Order for Enforcement of the Industrial Safety and Health Act, the Ordinance on Industrial Safety and Health, and the Ionizing Radiation Ordinance for Decontamination | 1 hour |

The special education shall also be provided by the training of the table below. General subject areas are in the left column, specific topics are in the middle column and the minimum time to be allotted is shown in the right column.

| Subject areas | Specific topics | Minimum duration |
|---|---|---|
| How to conduct works for handling designated contaminated soil and wastes and how to use the machinery for the work | 1) Practice of work for handling designated contaminated soil and wastes<br>2) Handling of radiation detectors<br>3) Monitoring of dose equivalent rate from external radiation<br>4) Measures to prevent contamination from spreading<br>5) Inspection of contamination on body and decontamination<br>6) Methods of using protective equipment<br>7) Handling of machines used for works for handling designated contaminated soil and wastes | 1 .5 hours |

2. The special educational lectures shall be provided to workers who engage in works under a designated dose rate.

The special education shall be provided by the lectures of the table below. General subject areas are in the left column, specific topics are in the middle column and the minimum time to be allotted is in the right column.

| Subject areas | Specific topics | Minimum duration |
|---|---|---|
| Knowledge about effects of ionizing radiation on a living body and exposure dose control methods | 1) Types and nature of ionizing radiations<br>2) Effects of ionizing radiation on cells, tissues, organs and the whole body<br>3) Exposure dose limit and methods of measuring doses<br>4) Method for confirming and recording the results of dose measurements | 1 hour |
| Knowledge about methods of measuring radiation | 1) Methods of measuring radiation<br>2) Monitoring of dose equivalent rate from external radiation<br>3) Emergency measures in case of abnormal events | 30 minutes |
| Relevant laws and regulations | Applicable provisions in the Industrial Safety and Health Act, Order for Enforcement of the Industrial Safety and Health Act, the Ordinance on Industrial Safety and Health, and the Ionizing Radiation Ordinance for Decontamination | 1 hour |