



**Illustrated  
Handbook**

**BOOKLET to Provide Basic Information  
Regarding Health Effects of Radiation**

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**Vol.2**

**Accident at TEPCO's Fukushima  
Daiichi NPS and Thereafter  
(Initiatives by Ministries and Agencies)**

**Radiation Health Management Division, Ministry of the Environment,  
Government of Japan**

**National Institutes for Quantum and Radiological Science and Technology**

**The booklet is also available on the website.**

► <https://www.env.go.jp/en/chemi/rhm/basic-info/>

QR Code





## Introduction

Seven years have passed since the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi Nuclear Power Station. In order to enable residents returning to areas where evacuation orders have been removed to rebuild their lives and revitalize respective communities as early as possible, support both for realizing early return and for assisting returners' new lives is indispensable. By April 2017, the government of Japan had sequentially removed evacuation orders, and the reconstruction and recovery of Fukushima Prefecture has been steadily progressing.

The national government must ensure that residents who have returned home can rebuild their lives smoothly without worries about their health due to the radioactive materials released by the accident. For that purpose, it is important to properly respond to their health problems such as through the Fukushima Health Management Survey, Comprehensive Health Check and easily accessible health counseling services by health nurses, and to provide correct information in an easy-to-understand manner on a timely basis.

Based on the Policy Package on Radiation Risk Communication for Achieving Residents' Return (2014), the national government has endeavored to disseminate correct and easy-to-understand information and has strengthened risk communication among a small number of people.

The Radiation Health Management Division, Environmental Health Department, Minister's Secretariat, Ministry of the Environment has collected and compiled basic knowledge on radiation, and scientific expertise and initiatives of relevant ministries and agencies concerning health effects of radiation, and has prepared a booklet to provide basic information since 2012, together with the National Institute of Radiological Sciences, National Institutes for Quantum and Radiological Science and Technology. This booklet has been utilized in training sessions targeting people engaging in health and medical care, welfare, and education or on other occasions with the aim of fostering personnel who can respond to residents' worries and concerns about their health in Fukushima and neighboring prefectures.

The Radiation Health Management Division and the National Institute of Radiological Sciences have jointly publicized the English version of the booklet, with cooperation of a group of experts, so that foreign nationals residing in Japan or visiting Japan or those interested in Japan can obtain basic knowledge on health effects of radiation and correctly understand changes in circumstances and efforts being made in Japan. As terms used in this field are highly professional and difficult, we also prepared a glossary. We would like to extend our gratitude to the people who offered cooperation in checking the translation and preparing the glossary.

The booklet is also available on the website of the Ministry of the Environment, from which you can download the content for use in training and classwork. We hope that this booklet will be utilized in diverse occasions.

January 2019

Radiation Health Management Division,

Environmental Health Department,

Minister's Secretariat,

Ministry of the Environment,

Government of Japan

&

National Institutes for Quantum and Radiological Science and Technology



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# Chapter 6

Situation concerning the Accident



## Damage due to the Great East Japan Earthquake

- A 9.0-magnitude earthquake occurred off the coast of Sanriku at 14:46 p.m. on Friday, March 11, 2011. The Earthquake and subsequent tsunami caused severe damage mainly to the Tohoku region.
- The earthquake was the largest ever recorded in Japan and the fourth biggest in the world since 1900.



Human damage	
Dead	15,894
Missing	2,546
Injured	6,156

Damage to buildings	
Completely destroyed	121,772
Half destroyed	280,921
Partially destroyed	726,509

(Surveyed by the National Police Agency; as of December 8, 2017)

Disaster victim support	
Evacuees nationwide	75,206

(Surveyed by the Reconstruction Agency; as of January 16, 2018)

A big earthquake centered off the coast of Sanriku occurred, at 14:46 p.m. on Friday, March 11, 2011. The seismic intensity of 7 on the Japanese earthquake scale was measured in Kurihara City, Miyagi Prefecture. This 9.0-magnitude earthquake was the biggest recorded in Japan since 1923 and the highest level in the world, equivalent to the 2010 Chili Earthquake (M8.8).

Included in this reference material on March 31, 2013

Updated on February 28, 2018

## Accident at the Nuclear Power Station

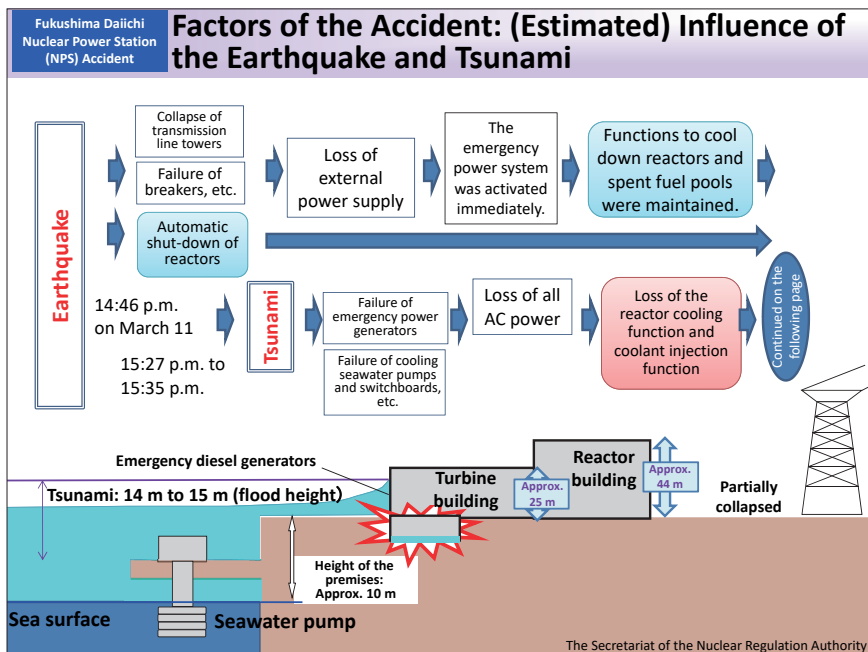


### **Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS Unit 3 (shot from the air)**

(Shot on March 16, 2011; Provided by TEPCO)

Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS Unit 1, Unit 2 and Unit 3, which were in operation at the time of the earthquake, lost all AC power due to the earthquake and subsequent tsunami. This led to the stop of the cooling system and loss of means to cool down nuclear fuels, eventually resulting in the melt of nuclear fuel. In the process of the melt, a large amount of hydrogen gas was generated and hydrogen gas accumulated in reactor buildings caused an explosion at Unit 1 on March 12 and at Unit 3 on March 14. Additionally, at Unit 4 adjacent to Unit 3, a hydrogen explosion occurred due to hydrogen gas that is considered to have flowed into it from Unit 3.

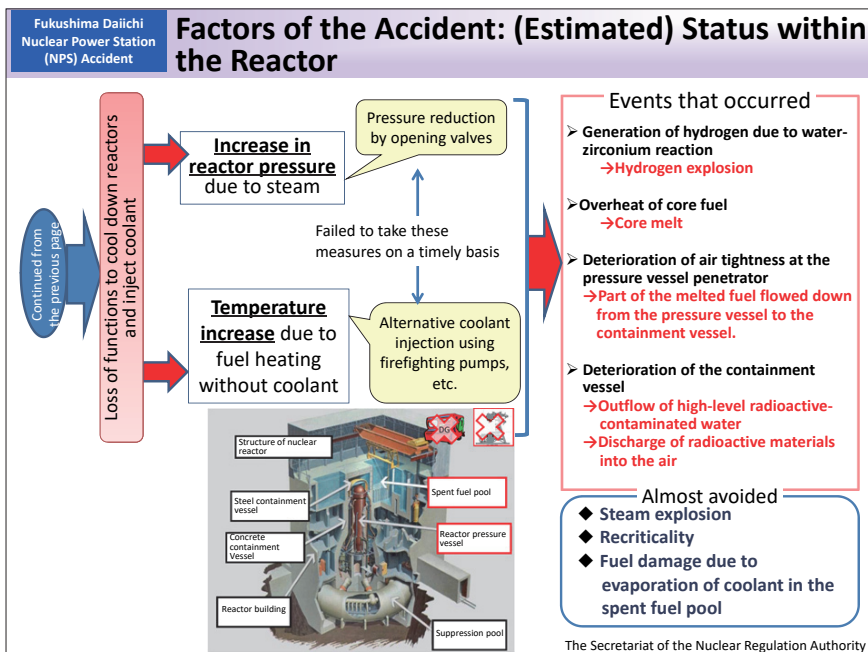
Included in this reference material on March 31, 2013



Immediately after the earthquake, at Unit 1, Unit 2 and Unit 3 at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS, which were in operation, all reactors were shut down automatically. As external electrical power supply was lost due to the collapse of transmission line towers, etc., emergency diesel generators were automatically activated. However, the tsunami hit the NPS and flooded those emergency diesel generators, switchboards and other equipment. All Units except for Unit 6 lost all AC power and cooling seawater pumps stopped functioning. As a result, Unit 1 lost all functions to cool down the reactor. Unit 2 and Unit 3 continued cooling reactors for some time using the Reactor Core Isolation Cooling System (RCIC) and the High Pressure Coolant Injection System (HPCI), respectively, which can work without AC power. However, these systems also stopped soon.

Under such circumstances, NPS staff worked to shift to alternative coolant injection using fire pumps or other equipment at Unit 1, Unit 2 and Unit 3, but until those alternative measures were commenced, reactor cores were left uncooled. Coolant injection is considered to have been suspended for around 14 hours at Unit 1 and for around 6.5 hours at Unit 2 and Unit 3.

Included in this reference material on March 31, 2013



As coolant injection to the reactor core was suspended, the water level in the reactor declined and the fuel was exposed. This caused core melt and damaged the pressure vessel. Additionally, under high temperature due to core damage, steam and zirconium of the fuel clad reacted to generate a large amount of hydrogen, which was released within the containment vessel together with steam.

In the meantime, core damage increased the temperature and pressure in the containment vessel and deteriorated its confinement function, causing gaps in such parts as the penetrator that extends to the outside of the containment vessel. Hydrogen generated due to the reaction of the steam and metal of the clad covering nuclear fuel leaked through the gaps into the reactor building and accumulated there. It led to a hydrogen explosion.

Coolant injected into the reactor leaked from the pressure vessel and containment vessel and a large amount of high-level radioactive-contaminated water accumulated underground below the reactor building and turbine building and partially flowed out into the ocean.


The damage to the pressure vessel and deterioration of the confinement function of the containment vessel caused a leak of steam containing radioactive materials. In addition, radioactive materials were discharged into the air due to hydrogen explosions at the reactor buildings and containment vessel vent operations.

In this manner, radioactive materials were released into the environment in the form of outflow of high-level contaminated water into the ocean and discharge of radioactive materials into the air.

Included in this reference material on March 31, 2013

Updated on January 18, 2016

Time	Event	Responses by Tokyo Electric Power Company (TEPCO)	Responses by the national government (Nuclear and Industrial Safety Agency)
March 11 14:46	The Great East Japan Earthquake occurred. (Seismic intensity 6 upper at Fukushima Daiichi Nuclear Power Station (NPS))	Fukushima Daiichi NPS Unit 1, Unit 2 and Unit 3 are automatically shut down by earth quake. Unit 4, Unit 5 and Unit 6 were under suspension due to periodic inspection.	The government established the Headquarters for Emergency Disaster Control, assembled officials at the Emergency Response Center, and dispatched officials to disaster-stricken areas by helicopter.
15:15			The Nuclear and Industrial Safety Agency held a press conference and provided information online.
15:27 15:35	The first tsunami (4m in height) arrived. The second tsunami (15m in height) arrived.		
15:42		Report under Article 10 of the Act on Special Measures Concerning Nuclear Emergency (Emergency generators activated at Units 1 to 5, which had lost all AC power, were damaged due to the tsunami.)	The government established the Nuclear Accident Vigilance Headquarters.
16:36		TEPCO judged that the events fall under Article 15 of the Act on Special Measures Concerning Nuclear Emergency.	
19:03			The government issued a Declaration of a Nuclear Emergency Situation and established the Nuclear Emergency Response Headquarters.
21:23			The government issued an evacuation order to residents within a 3-km radius of the NPS and ordered those within a 10-km radius to shelter indoors.
March 12 5:44			The government issued an evacuation order to residents within a 10-km radius of the NPS.
18:25			The government issued an evacuation order to residents within a 20-km radius of the NPS.



Aftershocks with seismic intensity 5 upper or less occurred several times.

From the report by the Aomori Prefecture Nuclear Safety Measure Verification Committee  
Prepared by the Nuclear and Industrial Safety Agency

The Secretariat of the Nuclear Regulation Authority

As the emergency core cooling system stopped at Unit 1 and Unit 2 of TEPCO's Fukushima Daiichi NPS, the government issued, based on the Act on Special Measures Concerning Nuclear Emergency, a Declaration of a Nuclear Emergency Situation and established the Nuclear Emergency Response Headquarters at 19:03 p.m. on March 11, 2011.

At 21:23 p.m. on the same day, based on the same Act, the government issued an evacuation order to residents within a 3-km radius of the NPS and ordered those within a 10-km radius to shelter indoors.

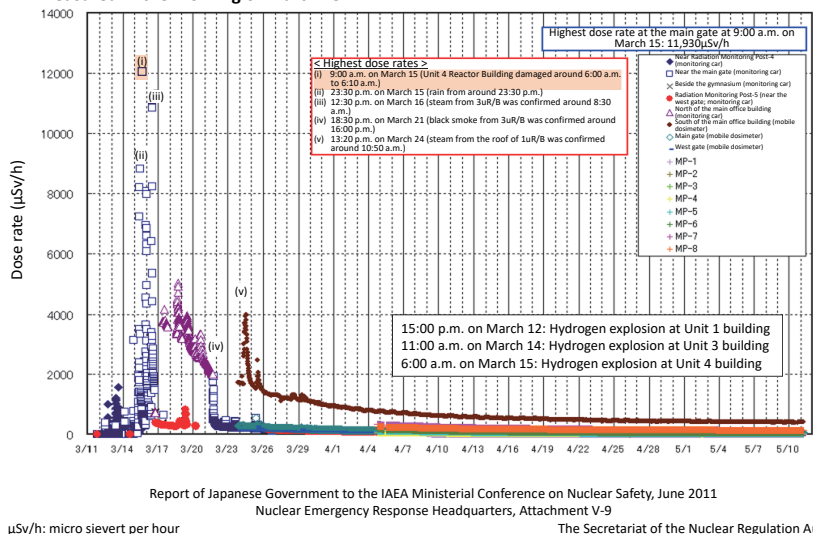
Thereafter, the government expanded the coverage of the evacuation order, which was targeted to residents within a 3-km radius of the NPS, to cover those within a 10-km radius. As a result, a total of 51,207 residents in four towns within a 10-km radius were placed under the evacuation order.

As a hydrogen explosion occurred within the reactor building at Unit 1 at 15:36 p.m. on March 12, the coverage of the evacuation order was further expanded from residents within a 10-km radius to those within a 20-km radius of the NPS.

Included in this reference material on March 31, 2013

## Ambient Dose Rates during Two Months after the Accident (Within and around of the premises of the Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi Nuclear Power Station (NPS))

Hydrogen explosions occurred at buildings, etc. at Unit 1 to Unit 4 and the highest dose rates were measured in the morning of March 15.



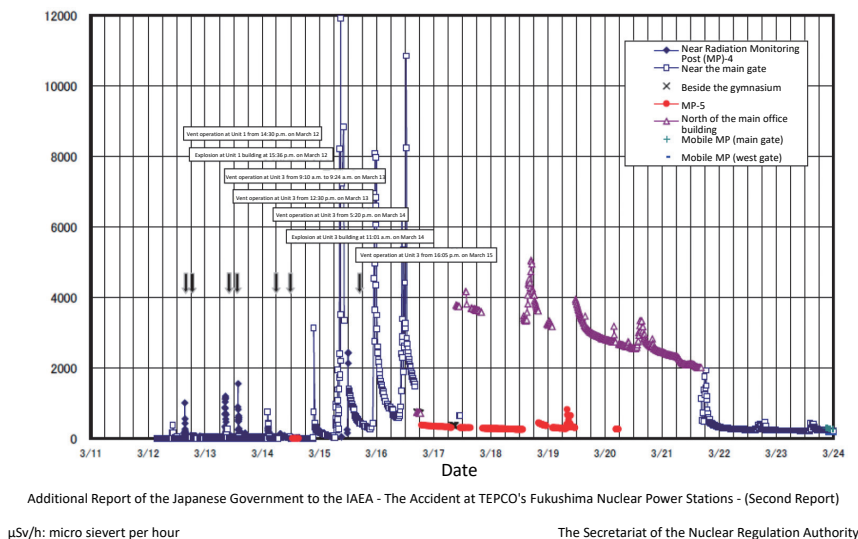
In the early morning of March 12, 2011, monitoring cars measured higher ambient dose rates within the premises of TEPCO's Fukushima Daiichi NPS and the release of radioactive materials was first confirmed after the earthquake. At Unit 1, after an abnormal pressure rise in the containment vessel was observed, the pressure declined slightly. Therefore, it is considered that radioactive materials leaked from the containment vessel at Unit 1 and were discharged into the air. Thereafter, temporary rises of ambient dose rates were observed several times after the vent operations and explosions at the buildings. The highest ambient dose rate was measured at 9:00 a.m. on March 15. A monitoring car near the main gate measured the highest rate of approx. 12 mSv/h.

Included in this reference material on March 31, 2013



## Ambient Dose Rates during Two Weeks after the Accident (Within and around of the premises of the Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi Nuclear Power Station (NPS))

### ● Changes in ambient dose rates measured by monitoring cars within and around the NPS



In accordance with the progress of events, radioactive materials were released into the air due to containment vessel vent operations and explosions at reactor buildings. Vent operation at Unit 1 was considered to be successful as the pressure in the containment vessel declined at 14:30 p.m. on March 12. Due to the radioactive plume discharged at that time, an ambient dose rate of approx. 1 mSv/h was detected. On March 13, the following day, the ambient dose rate clearly increased again. This is considered to have been caused by vent operation at Unit 3 conducted after the water level in the reactor declined and the fuel was exposed from cooling water. At 9:00 a.m. on March 15, the highest rate of approx. 12 mSv/h was observed. Early in the morning at around 6:00 a.m. of that day, the pressure of the pressure suppression chamber declined at Unit 2 with the sound of an explosion. Therefore, the high dose rate on March 15 is considered to have been caused by the release of radioactive materials from Unit 2.

Ambient dose rate increases were also measured at 23:00 p.m. on March 15 and at 12:00 p.m. on March 16. Pressure decline in the containment vessel was observed in Unit 3 and Unit 2, respectively, and these ambient dose rate increases are considered to have been caused by the release of radioactive materials from Unit 3 and Unit 2.

Included in this reference material on March 31, 2013

# International Nuclear Event Scale (INES)

	Level	Accident examples
Accident	7 Major accident	Former Soviet Union: Chernobyl Nuclear Power Plant accident (1986) Japan: Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi Nuclear Power Station (NPS) accident (2011)
	6 Serious accident	Provisionally evaluated as Level 7 on April 12, 2011
	5 Accident with wider consequences	UK: Windscale Nuclear Power Plant fire accident (1957) US: Three Mile Island Nuclear Power Plant accident (1979)
Abnormal incident	4 Accident with local consequences	Japan: JCO criticality accident (1999) France: Saint-Laurent Nuclear Power Plant accident (1980)
	3 Serious incident	Spain: Fire at Vandellós Nuclear Power Plant (1989)
	2 Incident	Japan: Damage to steam generator heat exchanger tube at Unit 2, Mihama NPS (1991)
Below scale	1 Anomaly	Japan: Sodium leak accident at Monju (1995) Japan: Primary coolant leak at Unit 2, Tsuruga NPS (1999) Japan: Pipe rupture in the residual heat removal system at Unit 1, Hamaoka NPS (2001) Japan: Pipe failure in the secondary system at Unit 3, Mihama NPS (2004)
	0 Below scale	(No safety significance)
	Not covered	(Events unrelated to safety)

Prepared based on "The International Nuclear and Radiological Event Scale User's Manual" (IAEA) and "Report of Japanese Government to the IAEA Ministerial Conference on Nuclear Safety" (June 2011; Nuclear Emergency Response Headquarters)

The International Nuclear Event Scale (INES) is the international indicator to show the level of the seriousness in terms of safety of accidents or trouble at nuclear power plants.

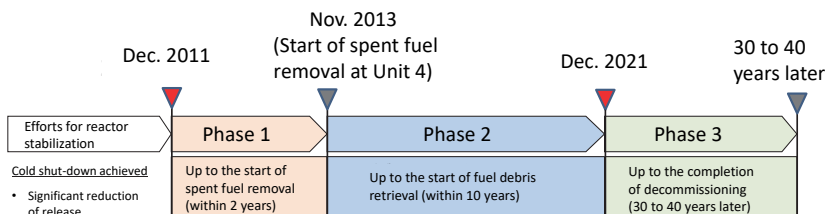
The accident at TEPCO's Fukushima Daiichi NPS was evaluated as Level 7 (radiation impact converted to the amount of I-131 exceeds several tens of thousands TBq (1016 Bq)), equivalent to the level of the Chernobyl accident.

(Related to p.28 of Vol. 1, "International Nuclear and Radiological Event Scale")

Included in this reference material on March 31, 2013

Updated on January 18, 2016

## Overall framework of decommissioning procedures



- Decommissioning procedures by roughly dividing the whole process into three phases
- This overall framework is maintained in the Mid- and Long-term Roadmap revised in September 2017.
- Fuel debris retrieval is scheduled to be commenced by the end of 2021.

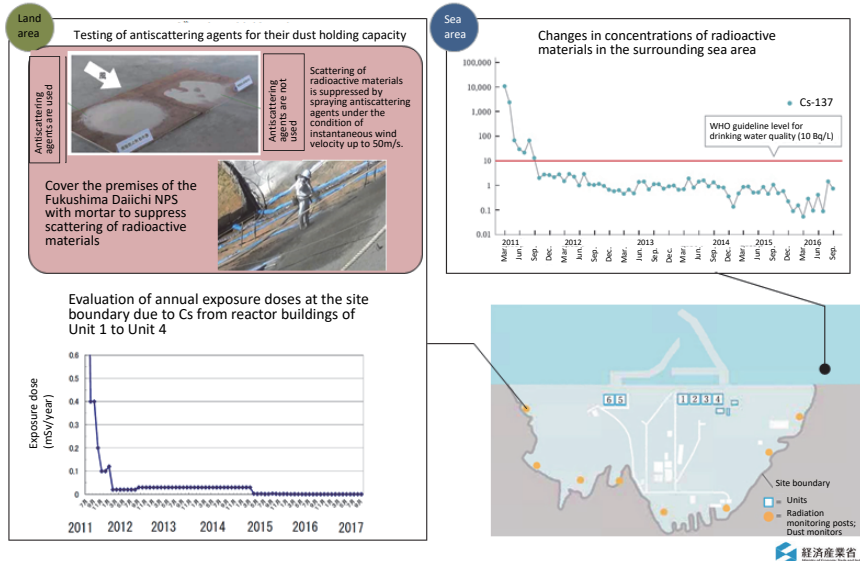
Efforts to stabilize damaged nuclear reactors have been continued at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS. At present, cooling of reactors is continued at all Units and they are all being kept stable and under control.

Procedures for decommissioning and contaminated water management are unprecedentedly challenging and the government of Japan takes the initiative to carry out measures stably and steadily in line with the Mid- and Long-term Roadmap towards the Decommissioning of Tokyo Electric Power Company Holdings' Fukushima Daiichi NPS (Mid- and Long-term Roadmap).

In September 2017, the Mid- and Long-term Roadmap was revised to incorporate the policy on fuel debris retrieval. However, the overall framework for completing the decommissioning in 30 to 40 years is maintained.

Decommissioning procedures will continuously be implemented while collecting wisdom from all over the world.

Included in this reference material on February 28, 2018



## < Sea area monitoring >

By the sea-side impermeable wall consisting of driven steel piles, which was completed in October 2015, and other various measures, concentrations of radioactive materials in the surrounding environment were reduced and have maintained levels far below the World Health Organization (WHO) guideline level for drinking water quality.

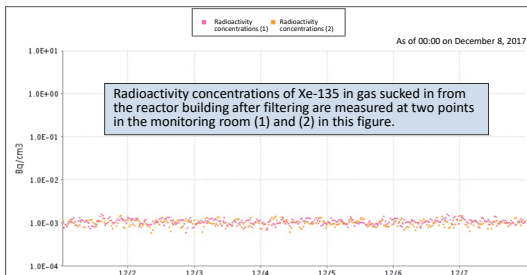
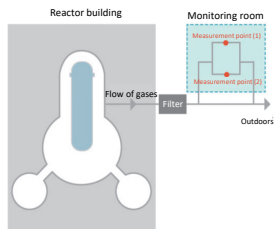
## < Surrounding area monitoring >

At the Fukushima Daiichi NPS, various measures are taken to prevent scattering of radioactive materials to outside of its premises. Representative measures being taken are spraying of antiscattering agents and facing of the ground with mortar. These measures have worked to stabilize measurement results at radiation monitoring posts within the premises.

Included in this reference material on February 28, 2018

## Measures against Recriticality and Future Earthquakes and Tsunamis

### ■ Amount of noble gases generated



### ■ Measures against earthquakes and tsunamis

Through computer analyses and other means, it has been confirmed that reactor buildings and other major facilities are sound enough to withstand any earthquakes or tsunamis equivalent to or even bigger than the Great East Japan Earthquake.

#### Securing of power sources in an emergency

In preparation for power loss, ordinary power sources have been multiplexed and emergency power supply vehicles and gas turbine vehicles are put in place. These vehicles are to be used to supply power to water injection facilities in an emergency.



Water injection drill



Emergency power supply vehicle



Fire engines

Backup power sources such as emergency power supply vehicles and water injection means such as fire engines are placed at a higher area where tsunamis are unlikely to reach.



Temporary seawall

(Source: Website of Tokyo Electric Power Company)



### < Recriticality >

When criticality occurs, Xe-135 and other noble gases increase in an unexpected fashion. At the Fukushima Daiichi NPS, generation of noble gases is being monitored at all hours. At present, the amount of noble gases has been stable, which suggests that recriticality has not occurred. However, in preparation for any risks of recriticality, a boric acid water system to suppress nuclear fission in the event of criticality has been installed.

### < Measures against earthquakes and tsunamis >

As measures against any earthquakes and tsunamis of the same level as the Great East Japan Earthquake, a temporary seawall has been constructed and the work to block openings of the buildings has been underway to prevent inflow of seawater in the event of a tsunami. Additionally, backup power sources such as emergency power supply vehicles and water injection means such as fire engines are placed at a higher area where tsunamis are unlikely to reach.

Included in this reference material on February 28, 2018

Premises of the Fukushima Daiichi NPS



Provided by Japan Space Imaging Corporation and (c) Digital Globe

Prepared by the Ministry of Economy, Trade and Industry based on the materials of Tokyo Electric Power Company



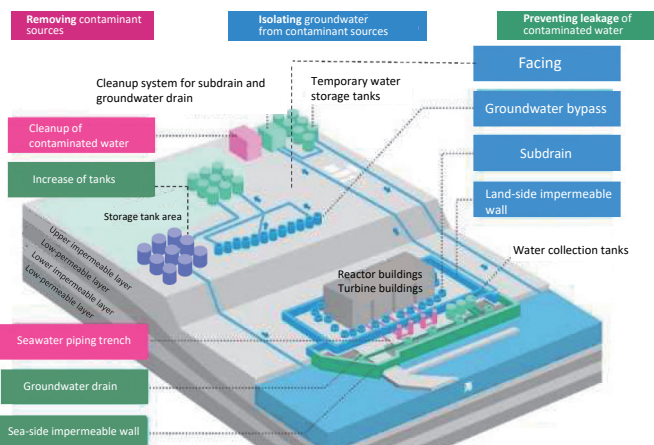
In order to improve safety and workability by reducing workers' load, efforts to improve the working environment, such as debris retrieval and facing, have been made at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS. As a result, areas where workers can work in ordinary work clothes expanded to approx. 95% of the entire premises in March 2017.

In May 2015, a large rest house was opened and workers are served with hot meals prepared at the food service center and can take a shower and buy things at a convenience store. They can thus work under normal working conditions at present.

Included in this reference material on February 28, 2018

## Measures against Contaminated Water

Preventive and multi-layered measures are being taken against contaminated water based on policies of (i) removing contaminant sources, (ii) isolating groundwater from contaminant sources, and (iii) preventing leakage of contaminated water.



Prepared by the Ministry of Economy, Trade and Industry based on the materials of Tokyo Electric Power Company



### < Policy 1: Removing contaminant sources >

(i) Clean up contaminated water with regard to 62 types of radionuclides excluding tritium(\*) by the use of the Advanced Liquid Processing System (ALPS) and other systems

(ii) Pump up highly contaminated water accumulated in the underground tunnel (trench) on the sea side of the buildings and fill and block the trench at the same time

⇒ Removal of contaminated water from the seawater piping trench and filling thereof was completed at Units 2 to 4 by December 2015.

\* Tritium is an isotope of hydrogen and exists in nature, in tap water and even in the human body. Comprehensive deliberations not only from a technological perspective but also from a social perspective are underway concerning the management of the water that has been treated and is stored in tanks.

### < Policy 2: Isolating water from contaminant sources >

(i) Pump up groundwater on a hill on the mountain side of the buildings to suppress inflow of groundwater around the buildings (groundwater bypass)

(ii) Pump up groundwater using the subdrain (a well near the buildings) to lower the groundwater level, thereby suppressing inflow of groundwater into the buildings and outflow of groundwater into the area on the sea side of the buildings

(iii) Construct a frozen soil wall closely around the buildings to suppress inflow of groundwater from outside of the frozen soil wall

(iv) Suppress infiltration of rainwater into soil by facing (pavement of the surface) to reduce the amount of groundwater and suppress inflow of groundwater into the buildings

⇒ By these preventive and multi-layered measures, the amount of contaminated water generated in a day decreased from 500m<sup>3</sup> in May 2014 to 200m<sup>3</sup> in the first half of FY2017.

### < Policy 3: Preventing leakage of contaminated water >

(i) Construct a sea-side impermeable wall made of steel pipes to reduce outflow of groundwater containing radioactive materials into the sea

(ii) Pump up groundwater using the groundwater drain in the seawall area to suppress outflow of groundwater into the sea

(iii) Secure tanks to store contaminated water generated every day and accumulated water in the buildings in a planned manner

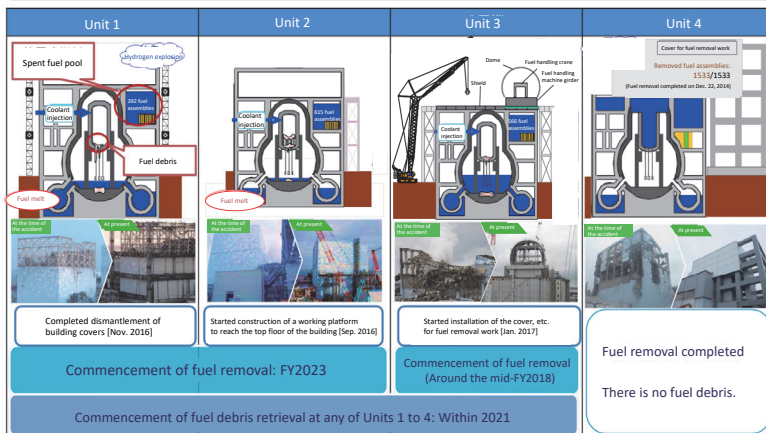
⇒ The sea-side impermeable wall was completed in October 2015 and radioactivity concentrations in the port decreased significantly.

Included in this reference material on February 28, 2018

## Decommissioning Measures

### Current status of Unit 1 to Unit 4 at the Fukushima Daiichi NPS

- Unit 1 to Unit 3 are being kept stable and preparation work for fuel removal from spent fuel pools is underway (debris retrieval, decontamination, shielding and installation of fuel removal equipment, etc.)
- Policies for the retrieval of fuel debris (fuel that melted at the time of the accident and then solidified) were decided. Concrete retrieval methods will be discussed from now on.



#### < Removal of spent fuel >

Removal of all 1,533 fuel assemblies from the spent fuel pool was completed at Unit 4 in December 2014 and risks were significantly reduced.

At present, preparations are being steadily progressed at Unit 1 to Unit 3 for removal of rubble. At Unit 3, a dome was installed and fuel removal is scheduled to be commenced around the mid-FY2018.

#### < Retrieval of fuel debris >

The Mid- and Long-term Roadmap revised in September 2017 indicates a step-by-step approach to first try to access the fuel debris existing at the bottom of the containment vessels (CVs) from the side in the air and then to expand the scale gradually.

Investigations of the inside of CVs by using robots based on cutting-edge technologies have been conducted so far. Investigations and R&D will be further continued with the aim of commencing removal of fuel debris at any Unit by the end of 2021.

(Source: Subcommittee on Management of ALPS-treated Water (1st meeting) on November 11, 2016)

[http://www.meti.go.jp/earthquake/nuclear/osensuitaisaku/committee/takakusyu/pdf/001\\_02\\_01.pdf](http://www.meti.go.jp/earthquake/nuclear/osensuitaisaku/committee/takakusyu/pdf/001_02_01.pdf) (in Japanese)

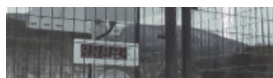
Included in this reference material on February 28, 2018



# Chapter 7

## Environmental Monitoring



Spatiotemporal  
Distribution of  
Ambient Dose RatesComprehensive Radiation Monitoring Plan and  
Information Disclosure

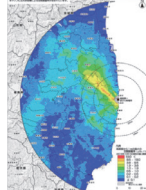
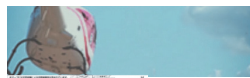
● Radiation Dose Map

Readings of nationwide radiation monitoring are shown in maps.

With location search function and location memory function



\* Select a prefecture.

**Real-time Dose Measurement System**

Ambient dose rates measured at mobile monitoring posts nationwide and by the Real-time Dose Measurement System are shown in a map.

**Airborne monitoring**

Monitoring using airplanes is conducted on a regular basis, centered on Fukushima Prefecture. The results are compiled into ambient dose rate maps and released.

**Sea area monitoring**

Relevant ministries and agencies conduct monitoring of seawater, marine soil and marine organisms and release measurement results.

Nuclear Regulation Authority; Monitoring information of environmental radioactivity level: <http://radioactivity.nsr.go.jp/a/> (in Japanese)

Comprehensive Monitoring Plan: <http://radioactivity.nsr.go.jp/a/list/204/list-1.html> (in Japanese)

The Monitoring Coordination Meeting established in the Nuclear Emergency Response Headquarters formulated the Comprehensive Monitoring Plan to ensure detailed monitoring of a large amount of radioactive materials released into the environment due to the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS. Based on this plan, relevant organizations and nuclear operators are collaboratively conducting monitoring, respectively focusing on the following.

1) General environment (soil, water, and atmosphere, etc.), water environment, sea areas, etc.

\* Released on the portal site of the Nuclear Regulation Authority

2) Schools, etc.

3) Ports, airports, and sewage, etc.

4) Wild fauna and flora, and waste

5) Cultivated soil, forests, and pasture grass, etc.

6) Tap water

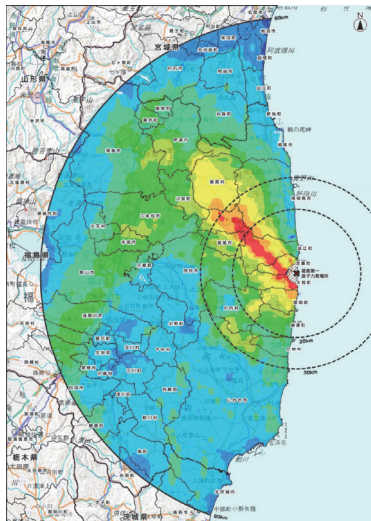
7) Foodstuffs (agricultural products, forestry products, livestock products, and fishery products)

Monitoring results are released on the websites of the respective organizations and are updated as needed.

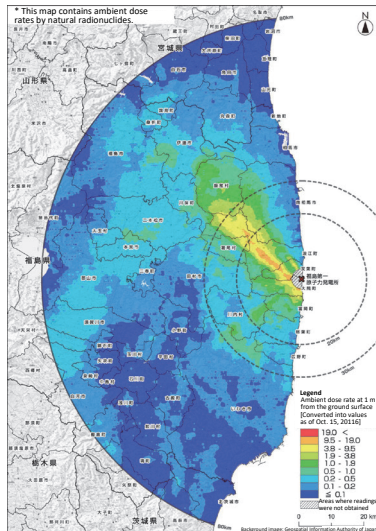
Included in this reference material on February 28, 2018

**Spatiotemporal  
Distribution of  
Ambient Dose Rates**

**Distribution of Ambient Dose Rates within the 80-km Zone of  
Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS**



Released by the Ministry of Education, Culture, Sports, Science  
and Technology (MEXT) on Dec. 16, 2011



Released by the Nuclear Regulation Authority on Feb. 13, 2017

In order to ascertain the changes in the effect of radioactive materials, the airborne monitoring survey has been conducted continuously within the 80-km zone of TEPCO's Fukushima Daiichi NPS, and the distribution of ambient dose rates and deposition of radioactive cesium have been surveyed. Additionally, the effect of radioactive materials outside the 80-km zone has also been ascertained through the airborne monitoring survey.

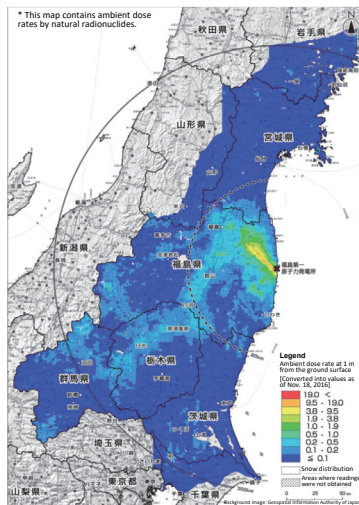
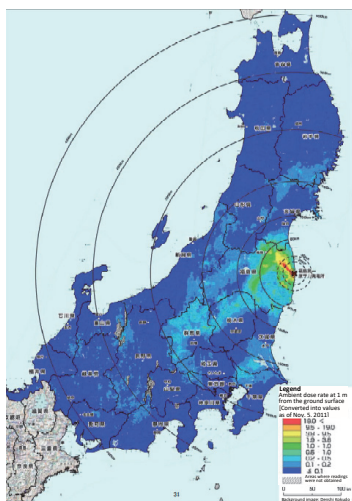
It was confirmed that ambient dose rates within the 80-km zone decreased over time both in areas showing higher dose rates (areas extending to the northwest of the NPS) and areas showing lower dose rates.

Included in this reference material on March 31, 2014

Updated on February 28, 2018

Spatiotemporal  
Distribution of  
Ambient Dose Rates

# Distribution of Ambient Dose Rates in Fukushima Prefecture and Neighboring Prefectures



From September to November 2016, an airborne monitoring survey was conducted within the 80-km zone of Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS and outside this zone, mainly in the western area of Fukushima Prefecture, and Ibaraki, Gunma, Tochigi and Miyagi Prefectures. When creating the map on the right, values were all converted into those as of November 18, 2016, which was the last day of the airborne monitoring survey.

Readings of the Airborne Monitoring Survey in Fukushima Prefecture and Neighboring Prefectures (February 13, 2017)

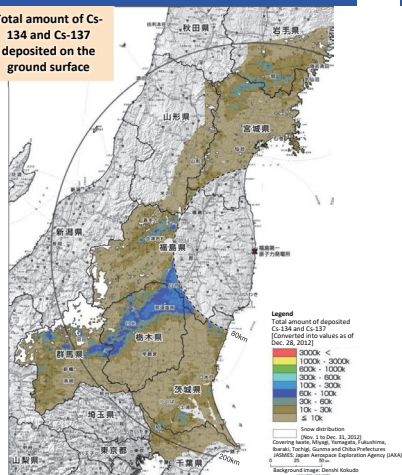
[http://radioactivity.nsr.go.jp/ja/contents/13000/12701/24/170213\\_11th\\_air.pdf](http://radioactivity.nsr.go.jp/ja/contents/13000/12701/24/170213_11th_air.pdf) (in Japanese)

Included in this reference material on March 31, 2013

Updated on February 28, 2018

**Readings of the Airborne Monitoring Survey  
outside the 80-km Zone  
(Converted into values as of Dec. 28, 2012)**

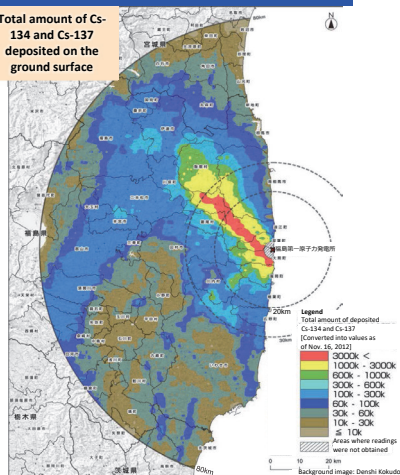
Total amount of Cs-134 and Cs-137 deposited on the ground surface



Bq/m<sup>2</sup> : becquerels per square meter

**Readings of the 6th Airborne Monitoring Survey  
within the 80-km Zone  
(Converted into values as of Nov. 16, 2012)**

Total amount of Cs-134 and Cs-137 deposited on the ground surface



Released by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) on March 1, 2013

These maps show deposition of radioactive cesium on the soil surface in Fukushima and neighboring prefectures based on the readings of the airborne monitoring survey.

The survey was conducted in October to December 2012 for the purpose of ascertaining the changes in the situation regarding the effect of radioactive materials including influence of rainfall or other natural environments. When creating these maps, values were all converted into those as of the last day of the relevant airborne monitoring survey, November 16, 2012, and December 28, 2012, respectively.

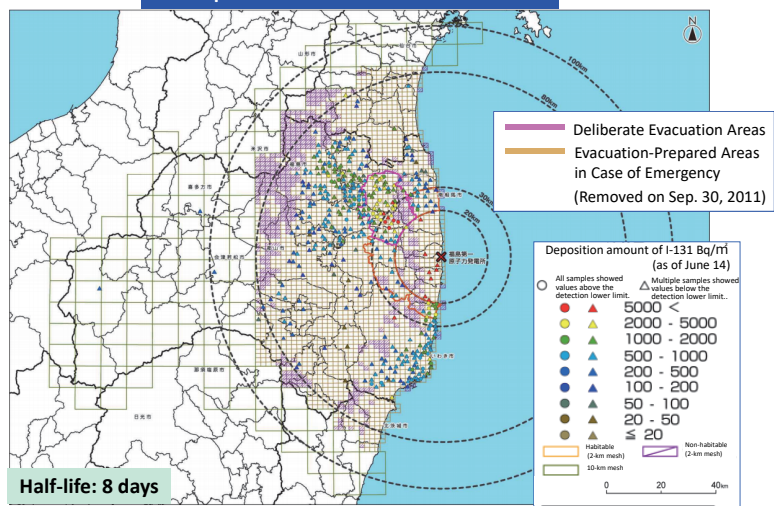
A comparison with the readings of the airborne monitoring survey on November 5, 2011, revealed that the ambient dose rates had decreased by some 40%. Since the decrease in ambient dose rates due to physical attenuation of radioactive cesium during this period was approx. 21%, it was confirmed that the declining trend within the 100-km zone of Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS (p.16 of Vol. 2, "Distribution of Ambient Dose Rates within the 80-km Zone of Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS") was larger than the general ambient dose rate decrease caused by physical attenuation of radioactive cesium.

Included in this reference material on March 31, 2013

Updated on February 28, 2018

## I-131 (Eastern Part of Fukushima Prefecture)

### Map of Concentration of I-131 in Soil



Released by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) on Sep. 21, 2011 (partially corrected on July 1, 2013)  
\*Converted into values as of June 14, 2011

In the soil survey conducted by the national government in June 2011, three months after the accident, analysis of I-131 was conducted for soil samples collected within the 100-km zone of Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS. While a band of areas showing high deposition amounts of cesium extended to the northwest of the NPS, areas showing high I-131 deposition amounts extended to the south of the NPS as well. I-131 and Cs-137 were thus deposited at different ratios in different areas because the ratio between I-131 and Cs-137 in radioactive plumes differed depending on the time when they were discharged. There is also the possibility that the ratio of I-131 against Cs-137 was relatively larger in plumes that flowed down to the south or that deposition was not even and a larger amount of Cs-137 was deposited in the north due to rainfall, resulting in increased concentrations of Cs-137 in soil in the north.

Included in this reference material on March 31, 2013

Updated on February 28, 2018

Iitate Village People's Forest  
"Sonmin no Mori Ai-no-Sawa" Camping Ground  
(Collected on March 17, 2011)

Weed (leaves) (Bq/kg)

• I-131	892,000
• Cs-134	314,000
• Cs-137	318,000

Land soil (soil) (Bq/kg)

• I-131	336,000
• Cs-134	32,000
• Cs-137	33,700

Inland water (pond water)  
(Bq/kg)

• I-131	2,480
• Cs-134	443
• Cs-137	476

Sampling location	Date	Weed (leaves) Bq/kg			Land soil (soil) Bq/kg		
		I-131	Cs-134	Cs-137	I-131	Cs-134	Cs-137
Towa branch municipal office, Nihonmatsu City	March 17	152,000	107,000	110,000	35,800	5,440	6,230
Swordsmanship dojo, Iitate Village	March 16	1,150,000	546,000	549,000	151,000	22,600	25,100
Ruins of Onami castle, Fukushima City	March 17	429,000	283,000	292,000	156,000	16,700	18,000

Bq/kg : becquerels per kilogram

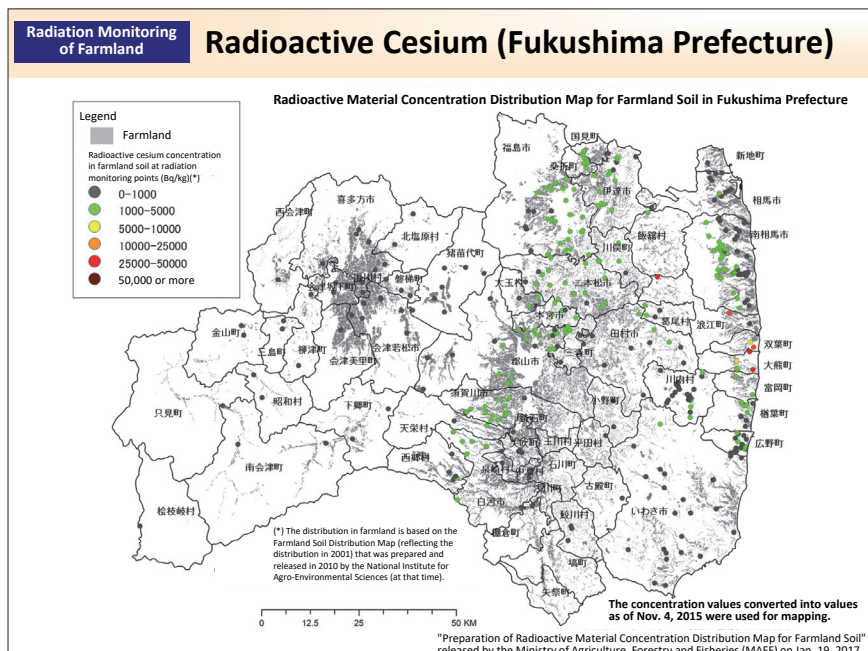
Prepared based on "Measurement Readings for Environmental Samples" on June 7, 2011, by the Ministry of Education, Culture, Sports, Science and Technology (MEXT)

Radiation monitoring of environmental samples have been conducted since March 15, 2011 and high level concentrations of radioactive iodine and radioactive cesium were detected from soil and plants.

Included in this reference material on March 31, 2013



## Radioactive Cesium (Fukushima Prefecture)



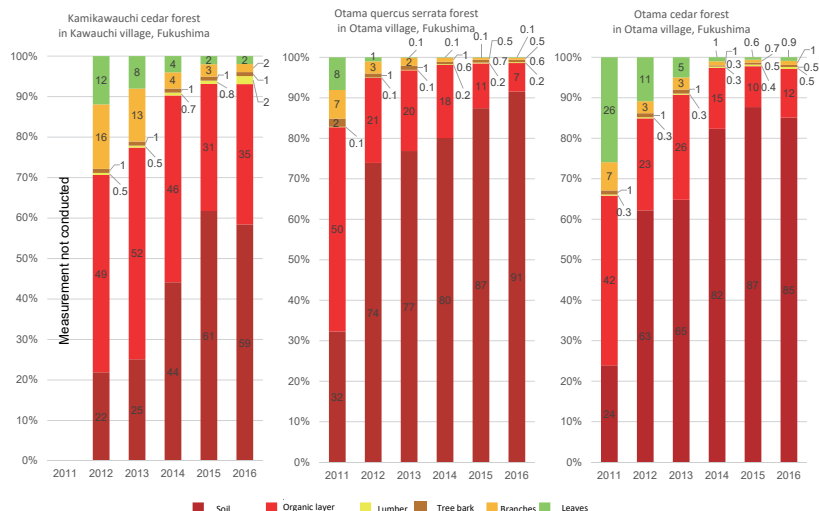
In order to promote future agricultural activities after the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS, levels of contamination of farmland soil with radioactive materials have been surveyed at 384 locations in Fukushima Prefecture.

In a general soil survey conducted by the Ministry of the Environment, soil samples are collected within a depth of approx. 5 cm from the ground surface. In this farmland soil survey, soil to a depth of approx. 15 cm from the ground surface was collected as samples in consideration of the depth of soil to be turned over in cultivation and to which crops take roots. The most recent survey results showed declines in radioactive cesium concentration from the previous survey results released on November 30, 2015 by approx. 8% in paddies, by approx. 18% in fields outside the Areas under Evacuation Orders, and by approx. 3% in both pastures and orchards. The decline in radioactive cesium concentration in soil due to physical attenuation during the same period was approx. 8%.

Included in this reference material on March 31, 2013

Updated on March 31, 2017

## Changes in Radioactive Cesium Distribution in Forests



"Readings of the FY2016 Survey results on the Distribution of Radioactive Materials in Forests," Forestry Agency

Radioactive cesium deposited on trees, leaves and branches, etc. in the surveyed forests gradually transferred into soil from 2011 to 2012 and the percentage of radioactive cesium found in soil increased significantly.

In the surveyed quercus serrata forest and cedar forest in Otama in Fukushima Prefecture, most of the radioactive cesium had transferred into soil in 2016, with the percentage of radioactive cesium in soil accounting for approx. 80% to 90% of the total. Radioactive cesium in organic layer slightly increased in the cedar forest in Otama in 2016 compared with the previous year.

In the surveyed cedar forest in Kamikawauchi in Fukushima Prefecture, there is a larger amount of leaves and branches of trees and a thicker organic layer, as observed in the graph.

Included in this reference material on January 18, 2016

Updated on February 28, 2018

## Readings of the Monitoring of Radioactive Cesium in Mountain Streams (2012)

Category	Snowmelt season (March 1 - April 30)		Rainy season (May 1 - July 31)		Autumn season (Aug. 1 - Oct. 31)
Total number of samples	118	(342)	184	(264)	175
Samples wherein Cs was not detected*1	111	(333)	181	(260)	169
Samples wherein Cs was detected*2	7	(9)	3	(4)	6
Concentration of Cs in samples wherein Cs was detected*3: (minimum - maximum) (Bq/L)	1.1~5.9	(1.0~5.9)	1.0~13.1	(1.0~13.1)	1.1~6.8
Percentage of samples wherein Cs was not detected	94.4%	(97.4%)	98.4%	(98.5%)	96.6%



Source: Prepared based on the Readings of the Monitoring of Radioactive Cesium in Mountain Streams (press releases by the Forestry and Forest Products Research Institute on June 12, Sep. 21 and Dec. 20, 2012)

Forestry Agency

Water samples collected from streams from forests in Fukushima Prefecture were inspected but radioactive cesium was not detected in most of them. Radioactive cesium was detected only in some of the samples, such as those collected on days with rainfall. These samples contained suspended solids with insoluble particles. Measurement was conducted again after filtering them and radioactive cesium was not detected in any of those filtered samples.

This suggests that radioactive cesium was detected mainly due to temporary increases in suspended solids, which are often observed when forest streams increase after rainfall.

\*1 Detection lower limits for both Cs-134 and Cs-137 are 1 Bq/L.

\*2 Samples wherein radioactive cesium was detected all contained suspended solids. As a result of the second measurement of those samples after filtering, radioactive cesium was not detected in any of them.

\*3 Concentration of radioactive cesium is the total of Cs-134 and Cs-137 concentrations.

\*4 Monitoring points were as follows:

Snowmelt season: Date City, Iitate Village, (Nihonmatsu City, Aizuwakamatsu City, Koriyama City and Hirono Town)

Rainy season: Date City, Iitate Village, (Nihonmatsu City)

Autumn season: Date City, Iitate Village

\*5 Values in the table are the readings for Date City and Iitate Village throughout these seasons. Values in the parentheses for the snowmelt season and rainy season contain the readings for the cities and the town in the parentheses indicated in \*4 above.

Included in this reference material on January 18, 2016

## Results of Well Water Inspection in Fukushima Prefecture

	Aizu District (western part of Fukushima Prefecture)	Nakadori District (central part of Fukushima Prefecture)	Hamadori District (eastern part of Fukushima Prefecture)
	Aizuwakamatsu City, Kitakata City, Nishiaizu Town, Bandal Town, Inawashiro Town, Aizubange Town, Yanaizu Town, Mishima Town, Kaneyama Town, Aizumisato Town, Kitashiobara Village, Showa Village, Shimogo Town, Tadami Town, Hinoemata Village	Fukushima City, Nihonmatsu City, Date City, Motomiya City, Koori Town, Kunimi Town, Kawamata Town, Otama Village, Sukagawa City, Tamura City, Ishikawa Town, Asakawa Town, Furudono Town, Miharu Town, Ono Town, Tenei Village, Tamakawa Village, Hirata Village, Shirakawa City, Yabuki Town, Tanagura Town, Yamatsuri Town, Hanawa Town, Nishigo Village, Izumizaki Village, Nakajima Village, Samegawa Village	Soma City, Minamisoma City, Hirono Town, Naraha Town, Kawauchi Village, Katsurao Village, Iitate Village, Iwaki City
2011	All ND	All ND	All ND
2012	All ND	All ND	All ND
2013	All ND	All ND	All ND
2014	All ND	All ND	All ND
2015	All ND	All ND	All ND
2016	All ND	All ND	All ND
2017	All ND	All ND	All ND

Measurement readings of radioactive materials in well water ND (not detected; below the detection lower limit): The detection lower limits for radioactive cesium and radioactive iodine were both 5 Bq/kg in 2011 and have been 1 Bq/kg since 2012.

\* All municipalities indicated above participate in the Fukushima Prefecture Monitoring Program for Radioactive Materials in Drinking Water. Some of the other municipalities conduct their own inspection.

Source: Prepared based on the "Results of Drinking Well Water Inspection (Jan. 16, 2018)," of the Fukushima Revitalization Station

Fukushima Prefecture's reconstruction information portal site, "Fukushima Revitalization Station," publicizes the results of the drinking well water inspection, which has been conducted since 2011, the year when the nuclear accident occurred. Based on the inspection system established under the Fukushima Prefecture Monitoring Program for Radioactive Materials in Drinking Water, the inspection has been conducted for municipalities upon their requests.

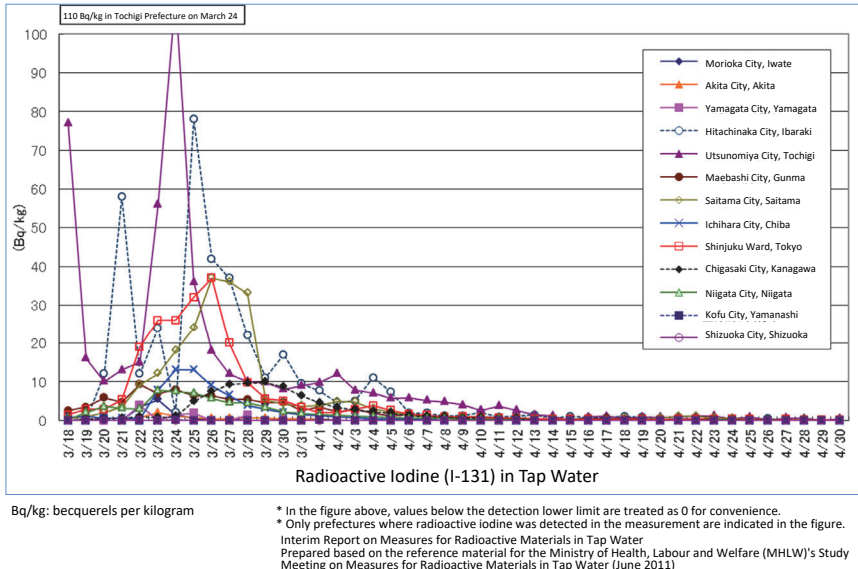
Fukushima Revitalization Station: "Drinking water"

<http://www.pref.fukushima.lg.jp/site/portal/list280-888.html> (in Japanese)

The national standard for drinking water including well water is 10 Bq/kg, but radioactive materials have never been detected from well water in the inspection conducted so far. Inspection results have been all "ND" (not detected; below the detection limit). The detection lower limits for radioactive cesium and radioactive iodine were both 5 Bq/kg in 2011 and are 1 Bq/kg at present.

Included in this reference material on February 28, 2018

## Radioactive Iodine (I-131) (the Tokyo Metropolis and 12 Prefectures)

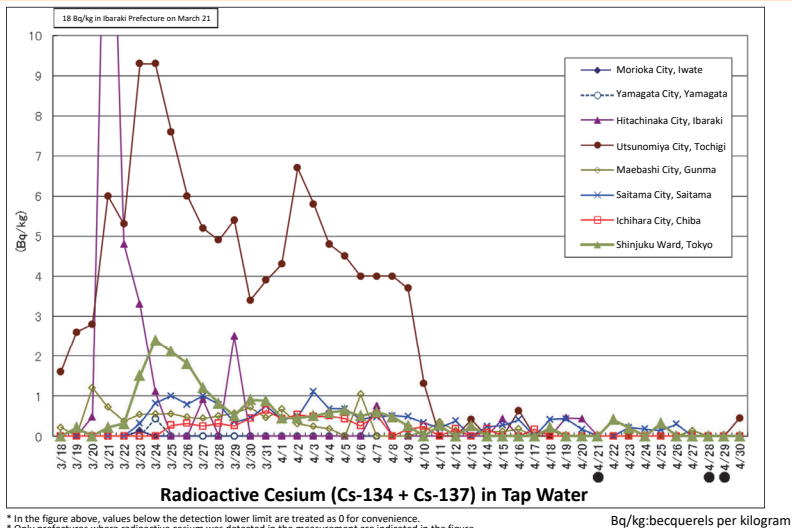


As a result of the inspection of radioactive materials in tap water conducted by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), radioactive iodine was detected in the Tokyo Metropolis and 12 prefectures out of 47 prefectures nationwide. Highest concentrations were detected at the respective locations from March 18 to 29, 2011, but I-131 concentrations turned to decrease in many locations in the latter half of March 2011. In and after April 2011, only small amounts of I-131 were detected at some of these locations.

Included in this reference material on March 31, 2013

Updated on January 18, 2016

## Radioactive Cesium (Cs-134 + Cs-137) (the Tokyo Metropolis and 7 Prefectures)



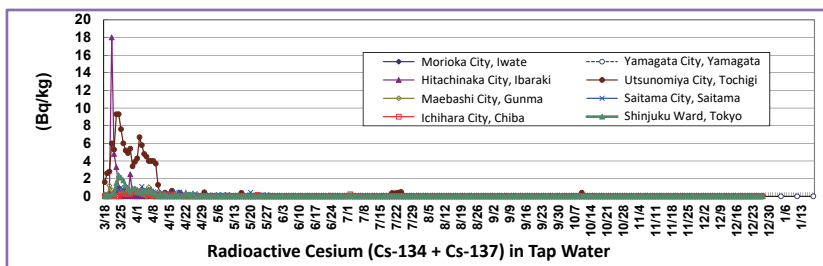
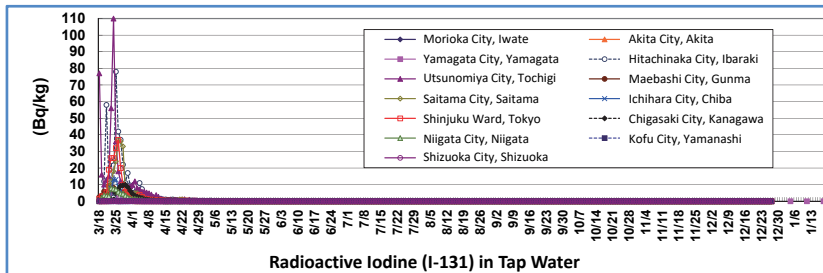
Interim Report on Measures for Radioactive Materials in Tap Water  
 Prepared based on the reference material for the Ministry of Health, Labour and Welfare (MHLW)'s Study Meeting on  
 Measures for Radioactive Materials in Tap Water (June 2011)

As a result of the inspection of radioactive materials in tap water conducted by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), radioactive cesium was detected in the Tokyo Metropolis and 7 prefectures out of 47 prefectures nationwide. Highest concentrations were detected at the respective locations from March 20 to early April 2011, but radioactive cesium concentrations were relatively smaller than radioactive iodine concentrations. In and after April 2011, only small amounts of radioactive cesium were detected at some of these locations.

Included in this reference material on March 31, 2013

Updated on January 18, 2016

## Results of Long-term Radiation Monitoring of Tap Water



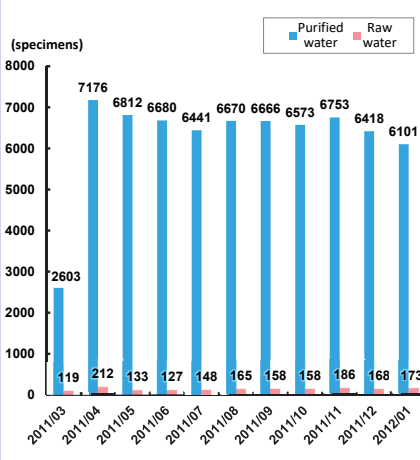
Committee on Living Environment and Water Supply in March 2012

The long-term tap water monitoring showed that radioactive cesium has seldom been detected since May 2011, not to mention short-half-life radioactive iodine.

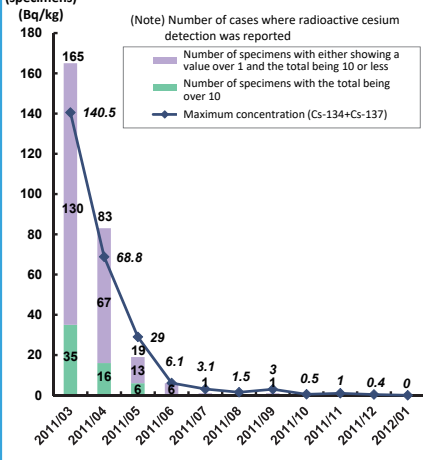
Included in this reference material on March 31, 2013

## Inspections by Water Suppliers

Changes in Number of Specimens for Radioactive Cesium Inspection



Detection of Radioactive Cesium (Purified Water)



Bq/kg: becquerels per kilogram

12th Health Sciences Council's Committee on Living Environment and Water Supply in March 2012

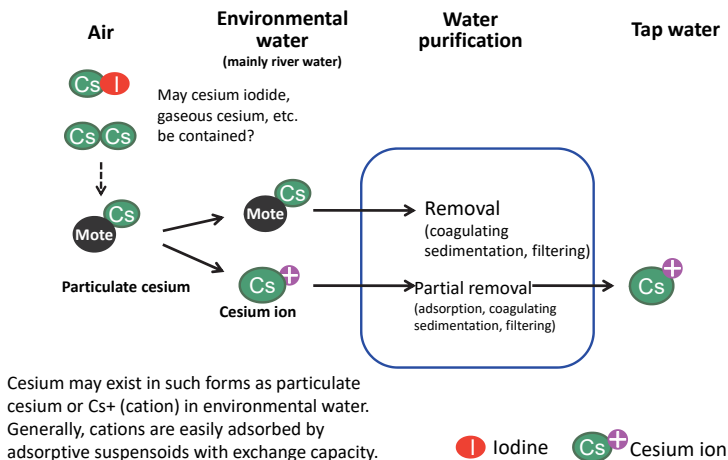
Water suppliers conduct inspections of radioactive cesium for approx. 6,000 to 7,000 specimens of purified water and over 100 specimens of raw water per month. The maximum monthly value of radioactive cesium concentration was 140.5 Bq/kg detected in March 2011, but the value declined gradually thereafter and there has been no report of radioactive cesium detection at a level exceeding 10 Bq/kg since June 2011.

Included in this reference material on March 31, 2013



# Behavior of Radioactive Cesium

## Conceptual Diagram of Behavior of Radioactive Cesium



Prepared based on the reference material for the 12th Health Sciences Council's Committee on Living Environment and Water Supply in March 2012

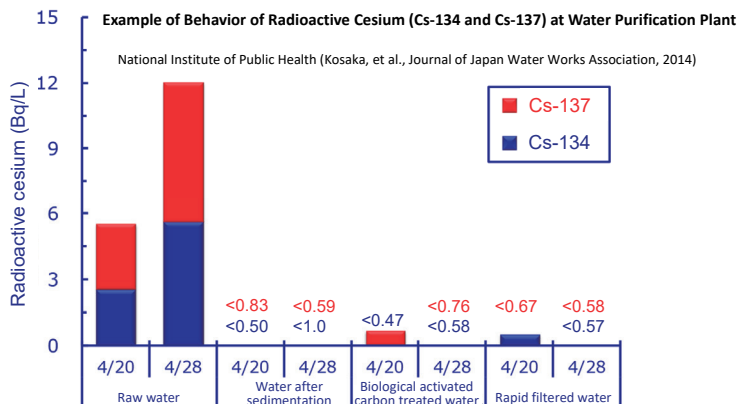
Radioactive cesium discharged due to the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS consists of Cs-134 and Cs-137 in equal proportion (1:1) and has also been detected at the same rate in the environment. Radioactive cesium was in the form of particles or gas immediately after discharge from the NPS, but it is considered to have fallen down onto the ground surface and to have been adsorbed into soil and particles, etc. In water, radioactive cesium is adsorbed into particles and tends to behave in the same manner as soil or other suspensoids, and therefore, is highly likely to be reduced by removing suspensoids in water.

Included in this reference material on March 31, 2013

Updated on January 18, 2016

## Control of Radioactive Cesium

Most of the radioactive cesium that reaches sources of tap water is adsorbed into suspensoids such as soil and flows out. Therefore, radioactive cesium can be controlled through strict turbidity management.



Zeolite, ion exchangers, nanofiltration membranes and reverse osmosis membranes are professionally used for removing radioactive materials, but these cannot be used for ordinary water purification due to high cost, required facilities and inefficiency (in particular, the use of nanofiltration membranes and reverse osmosis membranes is power consuming).

Bq/L: becquerels per liter

12th Health Sciences Council's Committee on Living Environment and Water Supply in March 2012

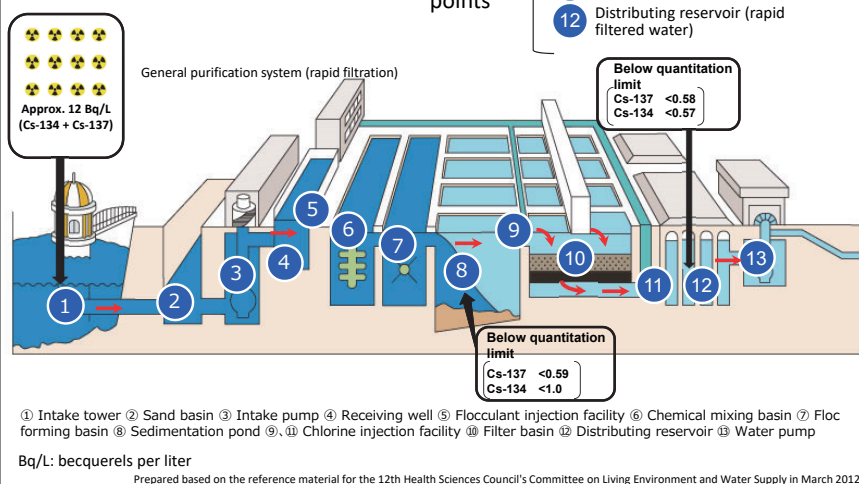
As of April 2011, radioactive cesium concentrations in raw water, water after sedimentation, biological activated carbon treated water, and rapid filtered water were measured at water purification plants in Fukushima Prefecture. As a result, it was confirmed that low-concentrated radioactive cesium detected in raw water had decreased through adsorption into soil in the process of sedimentation.

A survey of water purification processes revealed that radioactive cesium had been almost entirely removed together with suspensoids through coagulating sedimentation, sand filtration and the use of powdered activated carbon. At present, radioactive cesium is not detected in almost all purified water. These results showed that radioactive cesium can be controlled through strict turbidity management.

Included in this reference material on March 31, 2013

# Waterworks System

Changes in Radioactive Cesium Concentrations at Water  
Purification Plants in Fukushima Prefecture as of April 28, 2011  
National Institute of Public Health



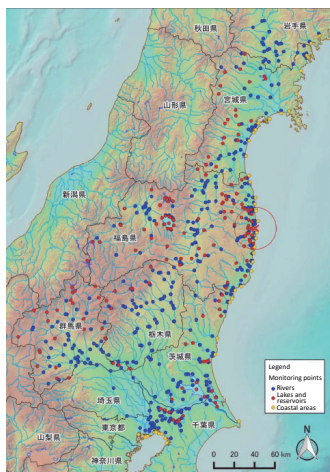
This figure shows the rapid filtration method, which is generally used in Japan. In this method, chemicals are injected into raw water taken from a river or dam to cause sedimentation of mud and small particles and make them into big chunks called "floc." Tap water is created by filtering the clear upper portion of such water.

Cesium has the property to be easily adsorbed into soil and mud (p.29 of Vol. 2, "Behavior of Radioactive Cesium"). Therefore, when water is separated from floc, cesium tends to gather around the floc, which is a chunk of soil and mud. Additionally, tap water is created using the clear upper portion of the water in plant basins. Therefore, this mechanism leaves little chance for cesium to be mixed into tap water.

In the pattern diagram above, radioactive cesium concentrations (Bq/L) actually measured at a water purification plant in Fukushima Prefecture as of April 28, 2011, are indicated at points where measurement was conducted. Radioactive cesium concentration, which was initially approx. 12 Bq/L at the intake tower, decreased to below the quantitation limit in the end when being pumped out from the distribution reservoir. It can be found that the concentration was far below 200 Bq/kg, which was the allowable limit for radioactive cesium in tap water publicized by the Ministry of Health, Labour and Welfare (MHLW) in March 2011, and also far below 10Bq/L, which is specified in the new standards for radioactive materials in tap water publicized in March 2012 (p.43 of Vol. 2, "Standard Limits Applied from April 2012").

Included in this reference material on March 31, 2015

Updated on February 28, 2018



[Coverage]

Whole Area of Fukushima, Miyagi, Ibaraki, Tochigi and Gunma Prefectures, and part of Iwate and Chiba Prefectures, etc.

[Monitoring points]

602 locations

[Radionuclide analyses]

< Samples >

Water, sediments and surrounding soil (rivers and lakes)

< Analyzed radionuclides >

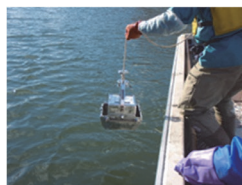
Radioactive cesium  
Radioactive strontium (only for some water and sediment samples)

[Frequencies]

Twice to 10 times a year depending on the contamination status, etc.



(River: water sampling)



(Lake: sediments sampling)

Results of the FY2016 Radioactive Material Monitoring in the Water Environment (Public Water Areas) by the Ministry of the Environment  
[http://www.env.go.jp/jishin/monitoring/results\\_r-pw-h28.html](http://www.env.go.jp/jishin/monitoring/results_r-pw-h28.html) (in Japanese)

Radioactive material monitoring was conducted at rivers, lakes and coastal areas in locations centered on Fukushima Prefecture, such as Miyagi and Ibaraki Prefectures, where contamination with radioactive materials was suspected.

In FY2016, monitoring covered 602 locations and analysis was conducted for radioactive cesium and strontium in water, etc.

[Monitoring results of radioactive cesium concentrations in water]

River water samples (2,004 samples): Radioactive cesium was not detected in any samples except for three collected at three locations in Fukushima Prefecture.

Lake water samples (1,352 samples): Radioactive cesium was not detected in any samples except for 34 collected at 13 locations in the Hamadori District, Fukushima Prefecture.

Water samples collected in coastal areas (534 samples): Radioactive cesium was not detected in any samples.

Included in this reference material on March 31, 2013

Updated on February 28, 2018

## Distribution of Radioactive Cesium Concentrations in River Sediments (FY2016)

Radioactive cesium concentrations [Bq/kg(dry)]	Number of collected samples												Percentage
	Iwate Prefecture	Miyagi Prefecture	Fukushima Prefecture, Hamadori District	Fukushima Prefecture, Nakadori District	Fukushima Prefecture, Aizu District	Ibaraki Prefecture	Tochigi Prefecture	Gunma Prefecture	Chiba Prefecture	Saitama Prefecture	Tokyo Metropolis	Total	
Less than 1,000	80	195	257	320	155	207	278	212	186	8	8	1,906	95.3%
1,000 or more but less than 2,000	0	1	39	4	0	5	0	1	8	0	0	58	2.9%
2,000 or more but less than 3,000	0	0	16	0	0	0	0	0	5	0	0	21	1.1%
3,000 or more but less than 4,000	0	0	6	0	0	0	0	0	0	0	0	6	0.3%
4,000 or more but less than 5,000	0	0	3	0	0	0	0	0	1	0	0	4	0.2%
5,000 or more but less than 10,000	0	0	5	0	0	0	0	0	0	0	0	5	0.3%
10,000 or more	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Total	80	196	326	324	155	212	278	213	200	8	8	2,000	

FY2016 Radioactive Material Monitoring in the Water Environment (Environmental Management Bureau, Ministry of the Environment)

Radioactive cesium concentrations in river sediments were measured in FY2016 as in the previous year.

A total of 2,000 samples, including 805 samples collected in Fukushima Prefecture and others collected in Iwate, Miyagi, Ibaraki, Tochigi, Gunma, Chiba and Saitama Prefectures and the Tokyo Metropolis, were surveyed.

The survey results showed that concentrations of radioactive cesium detected in approx. 95% of these samples were less than 1,000 Bq/kg(dry).

Included in this reference material on March 31, 2013

Updated on February 28, 2018

## Distribution of Radioactive Cesium Concentrations in Lake and Reservoir Sediments (FY2016)

Radioactive cesium concentrations [Bq/kg(dry)]	Number of collected samples									Percentage
	Miyagi Prefecture	Fukushima Prefecture, Hamadori District	Fukushima Prefecture, Nakadori District	Fukushima Prefecture, Aizu District	Ibaraki Prefecture	Tochigi Prefecture	Gunma Prefecture	Chiba Prefecture	Total	
Less than 1,000	61	55	29	142	65	29	69	26	476	58.0%
1,000 or more but less than 2,000	10	32	18	12	8	3	23	2	108	13.2%
2,000 or more but less than 3,000	2	15	9	10	3	0	4	4	47	5.7%
3,000 or more but less than 4,000	3	13	6	9	0	0	0	0	31	3.8%
4,000 or more but less than 5,000	0	15	2	5	0	0	0	0	22	2.7%
5,000 or more but less than 10,000	0	36	7	6	0	0	0	0	49	6.0%
10,000 or more	0	86	0	2	0	0	0	0	88	10.7%
Total	76	252	71	186	76	32	96	32	821	

FY2016 Radioactive Material Monitoring in the Water Environment (Environmental Management Bureau, Ministry of the Environment)

Radioactive cesium concentrations in lake and reservoir sediments were measured in FY2016 as in the previous year.

A total of 821 samples, including 509 samples collected in Fukushima Prefecture and others collected in Miyagi, Ibaraki, Tochigi, Gunma and Chiba Prefectures, were surveyed.

The survey results showed that concentrations of radioactive cesium detected in approx. 81% of these samples were less than 4,000 Bq/kg(dry).

Included in this reference material on March 31, 2013

Updated on February 28, 2018

## Distribution of Radioactive Cesium Concentrations in Coastal Area Sediments (FY2016)

Radioactive cesium concentrations [Bq/kg(dry)]	Number of collected samples							Percentage
	Iwate Prefecture	Miyagi Prefecture	Fukushima Prefecture	Ibaraki Prefecture	Chiba Prefecture	Tokyo Metropolis	Total	
Less than 1,000	4	52	150	20	23	18	267	100.0%
1,000 or more but less than 2,000	0	0	0	0	0	0	0	0.0%
2,000 or more but less than 3,000	0	0	0	0	0	0	0	0.0%
3,000 or more but less than 4,000	0	0	0	0	0	0	0	0.0%
4,000 or more but less than 5,000	0	0	0	0	0	0	0	0.0%
5,000 or more but less than 10,000	0	0	0	0	0	0	0	0.0%
10,000 or more	0	0	0	0	0	0	0	0.0%
Total	4	52	150	20	23	18	267	

FY2016 Radioactive Material Monitoring in the Water Environment (Environmental Management Bureau, Ministry of the Environment)

Radioactive cesium concentrations in sediments in coastal areas were measured in FY2016 as in the previous year.

A total of 267 sediment samples collected in coastal areas, including 150 samples collected in Fukushima Prefecture and others collected in Iwate, Miyagi, Ibaraki, Chiba Prefectures and the Tokyo Metropolis, were surveyed.

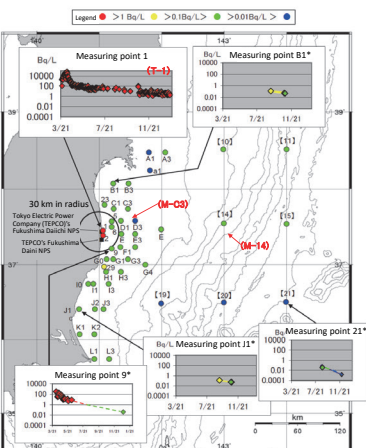
The survey results showed that concentrations of radioactive cesium detected in all of these samples were less than 1,000 Bq/kg(dry).

Included in this reference material on March 31, 2013

Updated on February 28, 2018

## Seawater

Readings of Radiation Monitoring of Sea Area (October 13 - December 1, 2011) (Cs-137 in Seawater)  
Readings of Sea Area Monitoring (Oct13-Dec01, 2011) Cs-137



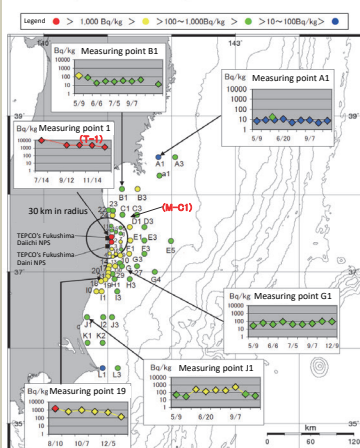
\* Initially, radiation monitoring was the major purpose and the detection lower limit was set higher (Cs-137: 9 Bq/L). Accordingly, the readings were often ND. Measuring points where the readings were ND are not plotted in the figure.

Bq/L: becquerels per liter Bq/kg: becquerels per kilogram

Prepared based on the reference material delivered at the 3rd Monitoring Coordination Meeting (on Jan. 24, 2012)

## Sea-bottom soil

Readings of Radiation Monitoring of Sea Area (December 5, 2011 - January 13, 2012) (Cs-137 in Sea-bottom Soil)  
Readings of Sea Area Monitoring (Dec 5-Jan13, 2011) Cs-137



\* Measuring point codes starting with alphabet: Bq/kg (dry); Measuring point codes without alphabet: Bq/kg (wet)

Since October 2011, radiation monitoring of radioactive cesium (Cs-137) in seawater and sea-bottom soil has been conducted jointly by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) (at that time), Secretariat of the Nuclear Regulation Authority (at present), Fisheries Agency, Japan Coast Guard, Japan Meteorological Agency, Ministry of the Environment (MOE), Fukushima Prefecture and TEPCO. With regard to samples collected near outlets, analysis has been conducted not only for radioactive cesium, but also for radioactive iodine (only for seawater samples), radioactive strontium, plutonium, and tritium (only for seawater samples).

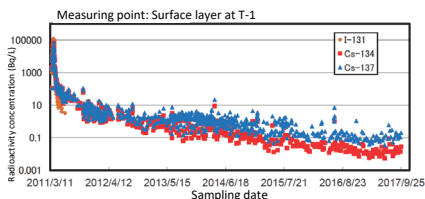
Included in this reference material on March 31, 2013

Updated on March 31, 2017

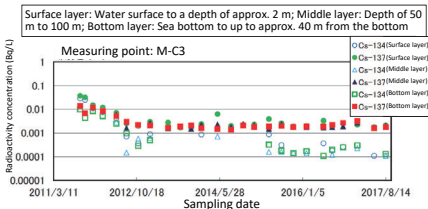


## Changes in Radioactivity Concentrations in Seawater

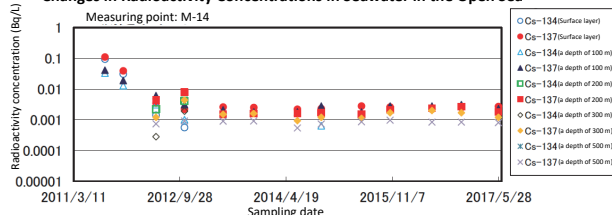
Changes in Radioactivity Concentrations in Seawater in Coastal Areas in and around Fukushima Prefecture



Changes in Radioactivity Concentrations in Seawater Offshore of Fukushima Prefecture



Changes in Radioactivity Concentrations in Seawater in the Open Sea



From the day of earthquake disaster to September 25, 2017

\* For measuring points, see p.36 of Vol. 2, "Radioactivity Concentrations in Seawater and Sea-bottom Soil."

Results of the Sea Area Monitoring by the Nuclear Regulation Authority: <http://radioactivity.nsr.go.jp/ja/list/428/list-1.html> (in Japanese)

Soil with radioactive cesium is transported to coastal areas via rivers.

Radioactivity concentrations in seawater samples collected in the coastal areas near Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS rose to 100,000 Bq/L immediately after the accident, but dropped to one-thousandth (100 Bq/L) in one and a half months. The concentrations further decreased to 10 Bq/L in one and a half years and are 1 Bq/L or less at present.

In six months after the accident, soil containing radioactive cesium was transported from the coastal areas to 30 km offshore, but the concentration detected at Measuring Point M-C3 was 0.05 Bq/L or one-200th of the concentrations detected in the coastal areas. In 2012, radioactivity concentrations were as low as 0.008 Bq/L in samples collected from bottom layers, where radioactivity concentrations are relatively higher. Radioactivity concentrations detected in samples collected from surface layers and middle layers also decreased.

In the open sea, 180 km away from the land, radioactivity concentrations detected in surface layers were 0.1 Bq/L, the same level of concentrations detected 30 km offshore, in six months after the accident. The concentrations further showed a two-digit decrease to 0.001 Bq/L in two years after the accident.

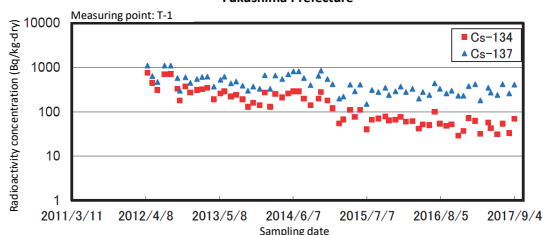
(Related to p.179 of Vol. 1, "Distribution of Radioactive Cesium in the Ocean")

Included in this reference material on March 31, 2014

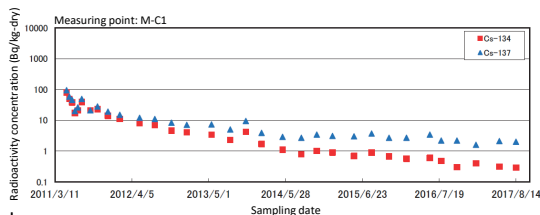
Updated on February 28, 2018

## Changes in Radioactivity Concentrations in Sea-bottom Soil

Changes in Radioactivity Concentrations in Sea-bottom Soil in Coastal Areas in and around Fukushima Prefecture



Changes in Radioactivity Concentrations in Sea-bottom Soil Offshore of Fukushima Prefecture



From the day of earthquake  
disaster to September 4, 2017

\* For measuring points, see p.36 of Vol. 2, "Radioactivity Concentrations in Seawater and Sea-bottom Soil."

Results of the Sea Area Monitoring by the Nuclear Regulation Authority: <http://radioactivity.nsr.go.jp/ja/list/428/list-1.html> (in Japanese)

As a result of measuring dried sea-bottom soil samples collected in the coastal areas near Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS, the concentrations of Cs-134 and Cs-137 were initially 1,000 Bq/kg but decreased in two years after the accident to 200 Bq/kg (down by 80%) and 500 Bq/kg (down by 50%), respectively.

Radioactivity concentrations detected from sea-bottom soil samples collected 40 km offshore (Measuring Point M-C1) rose to 100 Bq/kg immediately after the accident but decreased to 10 Bq/kg a year later.

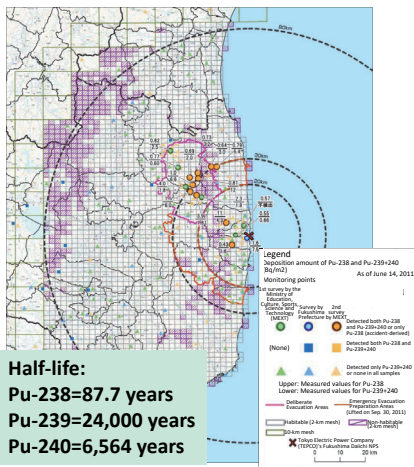
(Related to p.179 of Vol. 1, "Distribution of Radioactive Cesium in the Ocean")

Included in this reference material on March 31, 2014

Updated on February 28, 2018

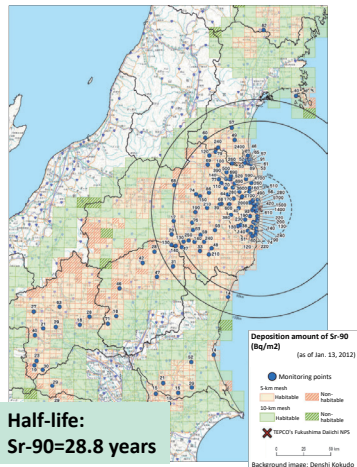
## Plutonium and Strontium (Eastern Part of Fukushima Prefecture, Wider Areas)

**Deposition Amount of Pu-238 and Pu-239+240  
(as of June 14, 2011)**



Bq/m<sup>2</sup>: becquerels per square meter

**Deposition Amount of Sr-90  
(as of Jan. 13, 2012)**



Left: Released by MEXT on Aug. 21, 2012 (partially corrected on July 1, 2013)

Right: Released by MEXT on Sep. 12, 2012 (partially corrected on Sep. 19, 2012 and July 1, 2013)

In the soil surveys conducted by the national government in June 2011 and January 2012, soil samples were collected within the 100-km zone of TEPCO's Fukushima Daiichi NPS and in the western part of Fukushima Prefecture outside this zone.

The amounts of deposited Pu-238 and Pu-239+240 detected in the surveys were found to be within their ranges in past measurements conducted from FY1999 to FY2009, before the accident, covering the whole nation. It means that the amounts were within the fluctuations due to past nuclear bomb tests in the atmosphere, except for the amount of Pu-238 detected in a sample collected at one location (p.176 of Vol. 1, "Effects of Nuclear Test Fallout (Japan)").

The amount of Pu-238 detected in a sample collected at one location exceeded the maximum deposition amount before the accident. It was around 1.4 times the maximum level before the accident. Based on the distribution of ratios between deposited Pu-238 and Pu-239+240 measured nationwide for 11 years from FY1999 to FY2009, locations where the ratios between Pu-238 and Pu-239+240 measured in the current surveys exceeded 0.053 were marked with ○ on the map. They are considered to be locations where the increased deposition amounts of Pu-238 and Pu-239+240 are highly likely to be attributable to the accident at TEPCO's Fukushima Daiichi NPS.

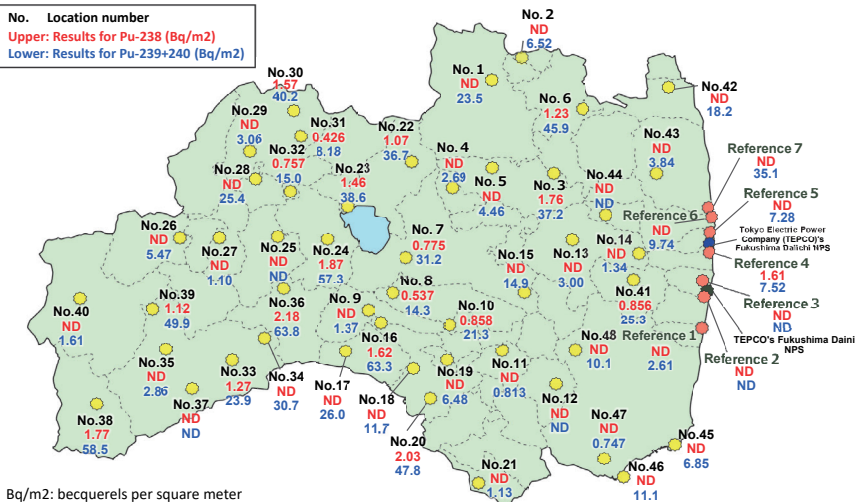
Sr-90 was also detected in the current surveys, but measured values for all samples were within the fluctuations due to past nuclear tests in the atmosphere in comparison with the readings of the nationwide measurements conducted from FY1999 to FY2009 before the accident at TEPCO's Fukushima Daiichi NPS. It was also confirmed that the deposition amounts of detected Sr-90 were around one-thousandth of those of Cs-137 at many of the monitoring points in the current surveys. Only occasionally, the deposition amounts of Sr-90 showed some fluctuations, being around one-tenth of those of Cs-137.

Included in this reference material on March 31, 2013  
Updated on February 28, 2018

# Plutonium (Fukushima Prefecture)

## Analysis Results for Pu-238 and Pu-239+240 (Soil)

No. Location number

Upper: Results for Pu-238 (Bq/m<sup>2</sup>)Lower: Results for Pu-239+240 (Bq/m<sup>2</sup>)

Prepared based on the reference material of the Local Nuclear Emergency Response Headquarters (Radioactivity Team) and the Disaster Provision Main Office of Fukushima Prefecture (Nuclear Power Team) of April 6, 2012

Based on the Plan for the Radiation Monitoring of Soil in Fukushima Prefecture, nuclide analysis for Pu-238 and Pu-239+240 was conducted for soil samples collected in Fukushima Prefecture from August 10 to October 13, 2011. Radioactive materials detected in all samples collected at monitoring points (48 locations) were within their ranges in past measurements conducted nationwide before the accident and the ratio between Pu-238 and Pu-239+240 was almost the same as the national average (0.0261) before the accident. Therefore, detected Pu-238 and Pu-239+240 in the current analysis are considered not accident-derived.

At one location (Ottozawa, Okuma Town) out of seven reference monitoring points around TEPCO's Fukushima Daiichi NPS, the ratio between detected Pu-238 and Pu-239+240 was 0.214, one digit higher than the national average (0.0261). It suggests that the location has the influence of the accident at TEPCO's Fukushima Daiichi NPS.

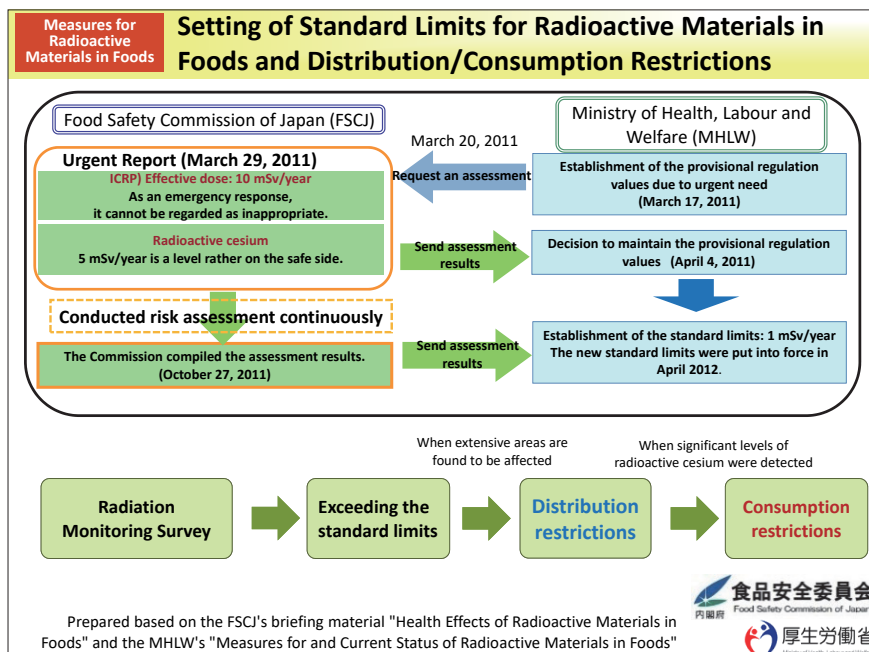
Included in this reference material on March 31, 2013

Updated on January 18, 2016

# Chapter 8

## Radioactive Materials in Foods





Generally, health effects caused by consumption of hazardous materials in foods are assessed by the Food Safety Commission of Japan (FSCJ), a risk assessment organization, which implements science-based risk assessments in an objective, neutral and fair manner. Based on the FSCJ's risk assessment, risk management organizations, such as the Ministry of Health, Labour and Welfare (MHLW) and the Ministry of Agriculture, Forestry and Fisheries (MAFF), formulate and implement risk management policies by establishing regulation values for each type of food.

However, under an emergency situation immediately after the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS, on March 17, 2011, the MHLW set the guideline values given by the Nuclear Safety Commission as the provisional regulation values for radioactive materials in foods. Then, the FSCJ held a total of five meetings, compiled the "Urgent Report on Radioactive Materials," and sent it to the MHLW on March 29, 2011. Based on this Urgent Report, the ministry decided to maintain the provisional regulation values as an interim measure.

In October 2011, the FSCJ notified the MHLW of the results of the risk assessment, and the MHLW reviewed the provisional regulation values and reduced the intervention level from 5 mSv/year to 1 mSv/year in order to further ensure security and safety considering the potential long-term effects of radiation exposure, in particular, radionuclides with relatively long half-lives. The new regulation was adopted on April 1, 2012.

Local governments conduct inspections of radioactive materials in foods based on their respective plans formulated in line with the guideline established by the Nuclear Emergency Response Headquarters. When any item with radioactivity concentration exceeding the standard values is found through an inspection, the relevant item is collected and disposed of. When extensive areas are found to be affected, the Director General of the Nuclear Emergency Response Headquarters (Prime Minister) issues distribution restrictions by designating the regions and the items.

When significant levels of radioactive materials are detected from a food item, consumption restrictions are promptly issued irrespective of the number of inspected samples of that item.

(Prepared based on the website of the Government's Public Relations Office (<http://www.gov-online.go.jp/useful/article/201204/3.html>, in Japanese) and the "Concepts of Inspection Planning and Establishment and Cancellation of Items and Areas to which Restriction of Distribution and/or Consumption of Foods Concerned Applies" (March 24, 2017), Nuclear Emergency Response Headquarters)

Included in this reference material on March 31, 2013  
Updated on February 28, 2018

Measures for  
Radioactive  
Materials in FoodsPublication of the Inspection Results  
Concerning Radioactive Materials in Foods

The national government proposes food items to be inspected and inspection frequencies, and respective prefectural governments formulate their inspection plans and carry out inspections accordingly.

Inspection results are publicized by the Ministry of Health, Labour and Welfare and respective local governments.

"Measures for Radioactive Materials in Foods," Ministry of Health, Labour and Welfare

[http://www.mhlw.go.jp/shinsai\\_jouhou/s/hokuhin.html](http://www.mhlw.go.jp/shinsai_jouhou/s/hokuhin.html) (in Japanese)

Database of radioactive substances in food:  
<http://www.radioactivity-db.info/> (in Japanese)

The screenshot displays the official website of the Ministry of Health, Labour and Welfare (MHLW) of Japan. The page is titled "東日本大震災関連情報" (Information related to the Great East Japan Earthquake). It features a navigation bar with links to "ホーム" (Home), "お問い合わせ" (Contact Us), "検索" (Search), and "RSS" (RSS). The main content area is divided into sections: "食品中の放射性物質への対応" (Response to radioactive substances in food), "食品中の放射性物質検査の状況" (Status of radioactive substance inspection in food), and "食品中の放射性物質検査の結果" (Results of radioactive substance inspection in food). The "食品中の放射性物質検査の結果" section lists inspection results for various food items, including "食品中の放射性物質検査の結果(食品中の放射性物質検査の結果)" and "食品中の放射性物質検査の結果(食品中の放射性物質検査の結果)". The page also includes a "トピックス" (Topics) section with links to various news items. The footer contains the MHLW logo and contact information.

In response to the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS on March 11, 2011, the provisional regulation values concerning radioactive materials were established on March 17, 2011, based on the Food Sanitation Act (Act No. 233 of 1947). Then, the "Concepts of Inspection Planning and Establishment and Cancellation of Items and Areas to which Restriction of Distribution and/or Consumption of Foods Concerned Applies" was compiled on April 4.

The "Concepts of Inspection Planning and Establishment and Cancellation of Items and Areas to which Restriction of Distribution and/or Consumption of Foods Concerned Applies" has been revised in light of the inspection results and accumulated knowledge on countermeasures to reduce radioactive materials (the latest revision was made on March 24, 2017).

Inspection results and information on distribution restrictions and consumption restrictions are positively publicized through websites of the national government and local governments.

Included in this reference material on February 28, 2018



- Immediately after the accident, foods in conformity to the provisional regulation values were generally assessed to have no ill effects and their safety was guaranteed. However, the annual dose limit was reduced to 1 mSv from 5 mSv, which had been permitted under the provisional regulation values, and current standard limits were set based thereon from the perspective of further ensuring security and safety of foods.

○ **Provisional regulation values for radioactive cesium\*<sup>1</sup>**

Category	Regulation value
Drinking water	200
Milk and dairy products	200
Vegetables	500
Cereals	
Meat, eggs, fish and others	

\*1 The regulation values were set also taking into consideration radioactive strontium.



○ **Present standard limits concerning radioactive cesium\*<sup>2</sup>**

Category	Standard limit
Drinking water	10
Milk	50
General foods	100
Infant foods	50

(Unit: Bq/kg)

\*2 The standard limits were set also taking into consideration radioactive strontium, plutonium, etc.

Prepared based on the Ministry of Health, Labour and Welfare's website, "Measures for Radioactive Materials in Foods"  厚生労働省

Even based on the provisional regulation values applied up to March 2012, safety of foods in conformity thereto was guaranteed in terms of the effects on human health. However, from the perspective of further ensuring the security and safety of foods, the current standard limits were established and have been applied since April 1, 2012.

First of all, the provisional regulation values were based on the premise that the annual radiation dose from foods does not exceed 5 mSv.

The present standard limits are based on the idea that the annual radiation dose from foods should not exceed 1 mSv. Additionally, foods were classified into five categories for the provisional regulation values, but were newly classified into four for the present standard limits. The standard limit for drinking water was set at 10 Bq/kg. The standard limit for milk, which children generally drink a lot of, was reduced to 50 Bq/kg. Additionally, a new category, "infant foods," was made for ensuring safety for infants and the standard limit therefor was set at 50 Bq/kg, the same as that for milk. The standard limit for other general foods is 100 Bq/kg. All foods other than infant foods were categorized as general foods based on the idea to minimize gaps in additional doses caused by differences in individuals' eating habits. The present standard limits are easier to understand for the general public and are also consistent with international views.

(Related to p.44 of Vol. 2, "Food Categories [Reference]," and p.47 of Vol. 2, "Approach for the Establishment of the Standard Limits • Grounds for the Standard Limits")

Included in this reference material on March 31, 2013

Updated on January 18, 2016

## Food Categories [Reference]

### ● Basic idea

Drinking water, infant foods and milk, for which special consideration is required, are separately classified into three different categories, while the others are all classified into a single category as general foods. In this manner, all foods and drinks are classified into four categories.

Food category	Reasons to establish the limits	Range of foods
<b>Drinking water</b>	<ol style="list-style-type: none"> <li>1. Water is essential for human life and there is no substitution for water, and its consumption is large.</li> <li>2. WHO's guidance level for radioactive cesium in drinking water is 10Bq/kg.</li> <li>3. Strict management is possible for radioactive materials in tap water.</li> </ol>	<input type="radio"/> Drinking water, water used for cooking and tea drinks, which is a substitute for water
<b>Infant foods</b>	<input type="radio"/> The Food Safety Commission pointed out that "the susceptibility to radiation may be higher in childhood than in adulthood."	<input type="radio"/> Foods approved to be labeled as "fit for infants" based on Article 26, paragraph (1) of the Health Promotion Act (Act No. 103 of 2002) <input type="radio"/> Foods and drinks sold as intended for infants
<b>Milk</b>	<ol style="list-style-type: none"> <li>1. Children consume a lot.</li> <li>2. The Food Safety Commission pointed out that "the susceptibility to radiation may be higher in childhood than in adulthood."</li> </ol>	<input type="radio"/> Milk (cow milk, low-fat milk, processed milk, etc.) and milk drinks specified in the Ministerial Order concerning the Ingredient Standards for Milk and Dairy Products (Order of the Ministry of Health and Welfare No. 52 of 1951)
<b>General foods</b>	For the following grounds, foods other than given above are categorized as "general foods." <ol style="list-style-type: none"> <li>1. Can minimize the influence of individual differences in eating habits (deviation of the foods to be consumed)</li> <li>2. Easy to understand for the general public</li> <li>3. Consistent with international views, such as those of the Codex Alimentarius Commission</li> </ol>	<input type="radio"/> Foods other than given above

Prepared based on the Ministry of Health, Labour and Welfare's website, "Measures for Radioactive Materials in Foods" 

Standard limits concerning radioactive materials in foods are established respectively for the four food categories.

For "drinking water," the standard limit was set at 10 Bq/kg due to the following three grounds: (i) Water is essential for human life and there is no substitution for water, and its consumption is large; (ii) WHO's guidance level for radioactive cesium in drinking water is 10Bq/kg; and (iii) Strict management is possible for radioactive materials in tap water (p.31 of Vol. 2, "Waterworks System").

For "milk," the standard limit was set at 50 Bq/kg because (i) children consume a lot and (ii) the Food Safety Commission pointed out that "the susceptibility to radiation may be higher in childhood than in adulthood."

For "infant foods," the standard limit is the same as that for milk at 50 Bq/kg as the Food Safety Commission pointed out that "the susceptibility to radiation may be higher in childhood than in adulthood."

As reasons to set the limit at 100 Bq/kg for "general foods," the following three points are cited: Setting the value in this manner (i) can minimize the influence of individual differences in eating habits (deviation of the foods to be consumed), and is (ii) easy to understand for the general public and (iii) consistent with international views, such as those of the Codex Alimentarius Commission (an intergovernmental body created for the purpose of protecting consumers' health and ensuring fair-trade practices in the food trade, etc. that establishes international standards for foods).

(Related to p.166 of Vol. 1, "Comparison of Regulation Values for Foods")

Included in this reference material on March 31, 2013

Updated on February 28, 2018

# Outline of the Results of the Food-related Health Risk Assessment

(Food Safety Commission of Japan (FSCJ), on October 27, 2011)

- Potential effects of radiation are found **when the lifetime additional effective cumulative dose exceeds around 100 mSv**. However, radiation dose accumulated in ordinary daily life such as from natural radiation and X-ray exams, etc. is excluded.

- In one's lifetime, **the susceptibility to radiation may be higher in childhood than in adulthood**. (thyroid gland cancer and leukemia)



- Risks of leukemia increased in children under the age of five at the time of the accident. (Noshchenko et al. 2010; Data relating to the nuclear accident at Chernobyl)
  - Risks of thyroid gland cancer are higher for children younger at the time of radiation exposure. (Zablotska et al. 2011; Data relating to the nuclear accident at Chernobyl)
- << However, both data contain uncertain points in the estimation of radiation doses, etc. >>

- **It is difficult to identify health effects concerning radiation exposure below 100 mSv.**



- Inaccuracy in estimation of the amount of exposure
- Effects of radiation and effects caused by other factors are unlikely to be distinguished.
- Study population for epidemiological data serving as grounds is not large enough.

食品安全委員会  
Food Safety Commission of Japan

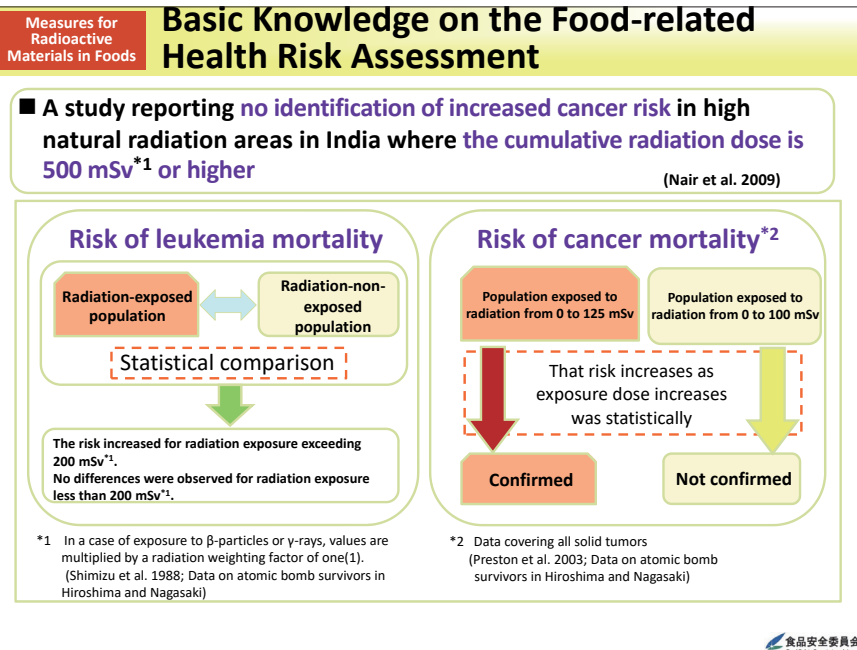
Based on currently available scientific knowledge, the FSCJ discussed additional radiation exposure through contaminated food consumption, and concluded that health effects could be found when the lifetime additional effective dose exceeds around 100 mSv, excluding radiation exposure from everyday life.

Although there are some unclear points in the estimation of radiation doses, etc., on the basis of findings of health effects after the accident at Chernobyl concerning risks of thyroid gland cancer and leukemia, it is likely that the susceptibility to radiation is higher in childhood than in adulthood (p.109 of Vol. 1, "Difference in Radiosensitivity by Age").

On the other hand, if any health effects may occur by exposure to radiation below 100 mSv, it would be very small. As effects of radiation and effects caused by other factors are unlikely to be clearly distinguished and the epidemiological data, due to the small study population, is insufficient to prove the health effects of additional exposure, such as a causal association with cancer, the FSCJ has concluded that it is difficult to identify health effects from the extra cumulative exposure to radiation doses below 100 mSv.

The lifetime additional effective cumulative dose of "around 100 mSv" is not a threshold meaning that radiation exposure below this level causes no health effects nor that radiation exposure above this level surely causes health effects. This is the dose value which risk management organizations should consider for appropriate management of foods.

Included in this reference material on March 31, 2013



This figure shows epidemiological data on which the Food-related Health Risk Assessment was based.

There was a study report that the increased cancer risk by radiation was not observed among persons exposed to radiation exceeding 500 mSv in total in areas in India where natural radiation doses are high (p.119 of Vol. 1, "Effects of Long-Term Low-Dose Exposure").

The data on atomic bomb survivors in Hiroshima and Nagasaki shows that the risk of leukemia mortality increased for the population exposed to radiation exceeding 200 mSv but that there was no statistically significant difference in the mortality risk between the populations exposed to radiation less than 200 mSv and not exposed to radiation (p.113 of Vol. 1, "Risks of Developing Leukemia").

Another report which analyzed the same data of atomic bomb survivors shows that for the population exposed to radiation from 0 to 125 mSv, it was statistically confirmed that the risk of cancer mortality increases as the exposure dose increases. However, for the population exposed to radiation from 0 to 100 mSv, no statistically significant difference was observed between radiation doses and the mortality risk. Based on these data, the result of the Food-related Health Risk Assessment was derived.

Included in this reference material on March 31, 2013

**Q. Why were the standard limits set based on the annual permissible dose of 1 mSv?**

**A. (i) They are in line with the international indicator based on scientific knowledge.**

**The Codex Alimentarius Commission, which establishes international specifications for foods, has set indicators so that the annual dose does not exceed 1 mSv.**

Note) The International Commission on Radiological Protection (ICRP) considers that stricter requirements below 1 mSv/year would not achieve any significant additional dose reduction. Therefore, based on this, the Codex Alimentarius Commission specifies indicators.

**(ii) They are intended to reduce radiation exposure as low as reasonably achievable.**

**Radiation monitoring surveys have shown considerable decreases over time in radioactivity concentrations measured in foods.**

Prepared based on the Ministry of Health, Labour and Welfare's website, "Measures for Radioactive Materials in Foods" 厚生労働省

The standard limits concerning radioactive materials in foods were set based on the annual permissible dose of 1 mSv, which is adopted by the Codex Alimentarius Commission that establishes international specifications for foods. Originally, the International Commission on Radiological Protection (ICRP) publicized the idea that stricter requirements below 1 mSv/year would not achieve any significant additional dose reduction. Based on this idea, the Codex Alimentarius Commission specifies indicators.

Additionally, the standard limits are based on the principle of ALARA (As Low As Reasonably Achievable) (p.161 of Vol. 1, "Optimization of Radiological Protection"). Radiation monitoring surveys have shown considerable decreases in radioactivity concentrations measured in many of the food samples. Therefore, it was found that the reduction of the standard limit for radioactive cesium concentrations in general foods to 100 Bq/kg would not cause any problem for the dietary patterns of the Japanese people.

Included in this reference material on March 31, 2013

Updated on January 18, 2016

**Q. Why are the standard limits set only for radioactive cesium?**

- The standard limits were set in consideration of all radionuclides whose half-life is one year or longer out of the radionuclides that are supposed to have been released due to the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS based on the assessment by the Nuclear and Industrial Safety Agency.

Regulated radionuclides	(Physical) half-life
Cesium 134	2.1 years
Cesium 137	30 years

Strontium 90	29 years
Plutonium	14 years -
Ruthenium 106	374 days

\* The standard limits are not set for radioactive iodine, which has a half-life as short as 8 days and is no longer detected, nor for uranium that exists within the premises of TEPCO's Fukushima Daiichi NPS at the same level as naturally occurring uranium.

- However, as measurements of radionuclides other than radioactive cesium take time, the standard limits are not set for each of them but are calculated and set so that the total dose from other radionuclides does not exceed 1 mSv if only the standard limits for radioactive cesium are met.

\* The maximum doses from radionuclides other than radioactive cesium that people may receive from foods can be calculated by age bracket based on such data as radioactivity concentrations in soil and easiness of transition of radioactive materials from soil to agricultural products. For example, for people aged 19 years or over, doses from radionuclides other than radioactive cesium account for approx. 12% of the total.

**A. While also taking into consideration effects of other radionuclides in calculation, cesium that accounts for the largest percentage and is most easily measured is used as the indicator.**

Prepared based on the Ministry of Health, Labour and Welfare's website, "Measures for Radioactive Materials in Foods"  厚生労働省

This figure shows the grounds why the standard limits are set only for radioactive cesium out of diverse radioactive materials.

All radionuclides whose half-life is one year or longer are taken into consideration, out of the radionuclides that are supposed to have been released due to the accident at TEPCO's Fukushima Daiichi NPS. Radionuclides shown in the table above, such as strontium 90, plutonium, and ruthenium 106, are taken into account in calculation, in addition to radioactive cesium. However, as the standard limits are intended for long-term regulations of radioactive materials in foods, radionuclides with a short half-life are not covered. For example, the standard limits are not set for radioactive iodine. Even if measurements are conducted for these other radionuclides by setting specific standard limits for each of them, it takes time to obtain measurement results. On the other hand, it is easy to measure radioactive cesium. Therefore, the standard limits are calculated and set so that the total dose from other radionuclides does not exceed 1 mSv if only the standard limits for radioactive cesium are met.

Specifically, effects of the radionuclides shown in the table above, such as radioactive cesium, strontium 90 and plutonium, were ascertained through surveys of soil, etc. For example, assuming the entirety of the effects caused by the consumption of foods containing radioactive materials released from TEPCO's Fukushima Daiichi NPS as 100, the effects of radioactive cesium account for around 88 in the case of people aged 19 years or over. On the other hand, the effects of the other radionuclides were found to account for around 12. In this manner, the standard limits were established also taking into consideration the effects of radionuclides other than radioactive cesium.

Included in this reference material on March 31, 2013

Updated on January 18, 2016

# Approach for the Calculation of the Standard Limits (1/2)

**How was the standard limit figured out to be 100 Bq/kg for general foods based on the annual permissible dose of 1 mSv?**

## 1. Preconditions for calculation

- For drinking water, the standard limit is set to be 10 Bq/kg in line with the WHO's guidance level.
  - The annual permissible dose allocated to general foods is approx. 0.9 mSv (0.88 to 0.92 mSv/y), which is obtained by subtracting that for drinking water (approx. 0.1 mSv/y) from the total annual permissible dose of 1 mSv.
- Domestically-produced foods are assumed to account for 50% of all distributed foods.
  - \* The standard limits are calculated on the assumption that domestically-produced foods contain radioactive materials at levels close to the maximum permissible limit.

## 2. Conversion from radioactivity concentrations (Bq) to radiation doses (mSv)

$$\text{Radiation dose (mSv)} = \text{Radioactivity concentration (Bq/kg)} \times \text{Amount of consumption (kg)} \times \text{Effective dose coefficient (mSv/Bq)}$$

Under the preconditions mentioned in 1. above, the maximum limit for radioactive materials in 1 kg of general foods is calculated so that doses from general foods do not exceed the annual permissible dose for general foods.

(e.g.) < In the case of males aged between 13 and 18 >

$$0.88 \text{ mSv} = X \text{ (Bq/kg)} \times 374 \text{ kg (50\% of the annual consumption of foods)} \times 0.0000181 \text{ (mSv/Bq)}$$

$X = 120 \text{ (Bq/kg) (rounded off to three digits)}$

\* For adults, the effective dose coefficient for Cs-134 is 0.000019 and that for Cs-137 is 0.000013. The effective dose coefficient thus differs by radionuclide. Therefore, based on respective radionuclides' concentration ratios in foods, the effective dose coefficient in consideration of the effects of all covered radionuclides was used for the calculation of the maximum limits.

\* Concentration ratios change over time as each radionuclide has a different half-life. Therefore, the coefficient on the safest side over the coming 100 years was adopted.

\* The above explanation is just the outline. For more detailed calculation methods, refer to the reference material of the Pharmaceutical Affairs and Food Sanitation Council.

Prepared based on the Ministry of Health, Labour and Welfare's website, "Measures for Radioactive Materials in Foods"  厚生労働省

This figure shows the approach for the calculation of the standard limits, explaining the relation between the annual additional dose limit (1 mSv) and the standard limit for general foods (100 Bq/kg).

First, the annual permissible dose allocated to general foods is assumed to be 0.88 to 0.92 mSv by subtracting approx. 0.1 mSv permitted for drinking water from the total annual permissible dose of 1 mSv. Next, domestically-produced foods and imported foods are assumed to account for 50% each of all distributed foods. Then, in the case of males aged between 13 and 18, it is assumed that 374 kg of foods or 50% of the total annual consumption per person (approx. 748 kg) is domestically produced. The effective dose coefficient in consideration of the effects of all covered radionuclides (0.0000181 mSv/Bq) is to be used for calculation.

Then, the calculation formula is as follows.

$$0.88 \text{ mSv} = (\text{Radioactivity concentration: Bq/kg}) \times 374 \text{ kg} \times 0.0000181 \text{ (mSv/Bq)}$$

$$(\text{Radioactivity concentration: Bq/kg}) = 120 \text{ Bq/kg}$$

If radioactivity concentrations in general foods do not exceed 120 Bq/kg, the annual additional dose will be within 0.88 mSv.

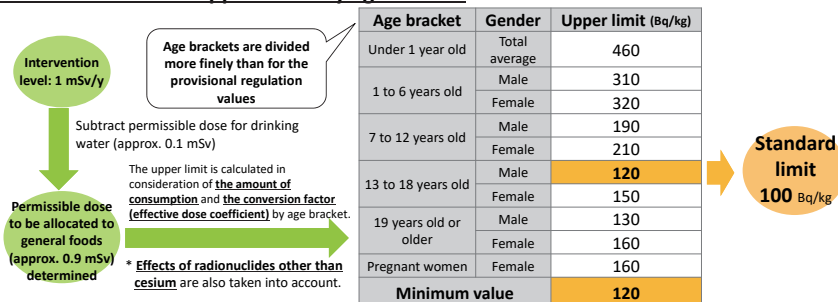
Therefore, the standard limit for general foods (100 Bq/kg), which is lower than 120 Bq/kg, is the value set on the safe side to guarantee safety.

Included in this reference material on March 31, 2013

Updated on January 18, 2016

## Approach for the Calculation of the Standard Limits (2/2)

### 3. Calculation of the upper limits by age bracket



**The standard limit is set based on the strictest upper limit (the minimum value) out of those for all age brackets.**

- The standard limit results in reflecting requirements for all age brackets.
- The standard limit secures an extra margin of safety from the upper limit especially for infants.

### 4. Standard limits for milk and infant foods

These categories are established in consideration of young children. Therefore, the standard limits should be stricter so that consumption of these foods would not cause any harmful effects even if all of them contain radioactive materials up to the upper limits.

→ The standard limits for milk and infant foods are both set to be 50 Bq/kg, namely half of the 100 Bq/kg for general foods.



Prepared based on the Ministry of Health, Labour and Welfare's website, "Measures for Radioactive Materials in Foods"

The idea of figuring out dose limits for each age bracket underlies the basic approach for setting the standard limits.

The annual permissible dose allocated to general foods is approx. 0.9 mSv, subtracting that for drinking water from the total.

The table above shows upper limits (Bq/kg) by age bracket calculated based on the annual consumption and the effective dose coefficient for each age bracket.

As a result, the strictest upper limit was found to be 120 Bq/kg for males aged between 13 and 18.

In order to ensure safety for all age brackets, the standard limit was set to be 100 Bq/kg on the safe side, below the strictest upper limit of 120 Bq/kg.

Included in this reference material on March 31, 2013

Updated on January 18, 2016



## Survey of Distributed Foods (Market Basket Survey)

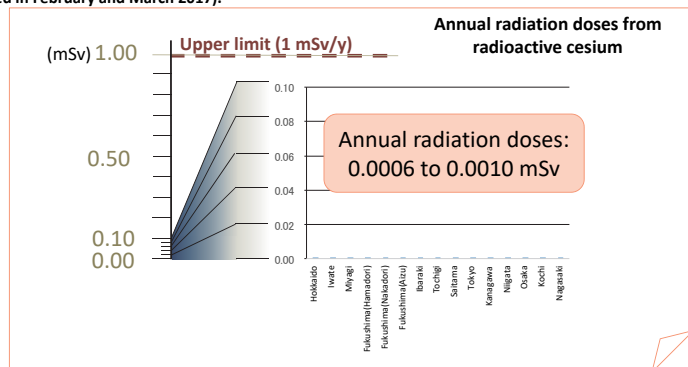
- A survey was conducted by purchasing foods distributed nationwide and precisely measuring radioactive cesium contained therein.

Foods were purchased based on average food consumption by region (based on the National Health and Nutrition Survey) and purchased foods were mixed for measurement.

◆ Purchased foods were simply cooked in line with ordinary dietary circumstances and measurement was conducted.

◆ Regarding fresh foods, those produced in the relevant region or the neighboring areas were chosen if possible.

- Based on the measurement results, radiation doses that people would intake from foods in a year were calculated (surveyed in February and March 2017).



Measured effective doses were 1% or lower of 1 mSv/y, based on which the standard limits were established.

Prepared based on the Ministry of Health, Labour and Welfare's website, "Measures for Radioactive Materials in Foods" 厚生労働省

From February to March 2017, the Ministry of Health, Labour and Welfare conducted a survey by purchasing distributed foods in 15 areas across Japan and measuring radioactive cesium contained therein to estimate annual radiation doses received from radioactive cesium in foods.

Annual radiation doses received from radioactive cesium in foods were estimated to be 0.0006 to 0.0010 mSv, 1% or lower of the annual permissible dose of 1 mSv/y, based on which the standard limits were established. Thus, annual radiation doses were confirmed to be extremely small.

Market basket survey:

One of the survey methods for estimating daily consumption of various chemical substances

(Source: Ministry of Health, Labour and Welfare's website: [http://www.mhlw.go.jp/shinsai\\_jouhou/market\\_basket.html](http://www.mhlw.go.jp/shinsai_jouhou/market_basket.html), in Japanese)

Included in this reference material on March 31, 2013

Updated on February 28, 2018

Measures for Radioactive Materials in Foods		Prefectures and Food Items to be Inspected (Items for which Cultivation/Feeding Management is Difficult and Log-grown Mushrooms)																
Food items for which cultivation/feeding management is difficult and relevant prefectures to be inspected																		
		Aomori	Iwate	Akita	Miyagi	Yamagata	Fukushima	Ibaraki	Tochigi	Gunma	Chiba	Saitama	Tokyo	Kanagawa	Niigata	Yamanashi	Nagano	Shizuoka
Items with radioactivity concentrations exceeding the standard limits	Wild mushrooms and wild plants	□	●	□	●	●	●	●	●	●	●	□	□	□	●	●	●	●
	Wild bird and animal meat	□	□	□	□	●	●	●	●	●	●	□	□	□	□	□	□	□
Items with radioactivity concentrations exceeding half of the standard limits but not exceeding the standard limits	Wild mushrooms and wild plants	□	□	●	●	□	●	□	●	□	□	□	□	□	□	□	□	□
	Honey	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—	—	—
	Marine fish	—	□	—	□	—	●	●	×	×	●	×	—	—	—	×	×	—
	Inland water fish	—	●	—	●	—	●	●	●	●	●	—	—	—	—	—	—	—
Log-grown mushrooms to be inspected and relevant prefectures to be inspected																		
		Aomori	Iwate	Akita	Miyagi	Yamagata	Fukushima	Ibaraki	Tochigi	Gunma	Chiba	Saitama	Tokyo	Kanagawa	Niigata	Yamanashi	Nagano	Shizuoka
Log-grown mushrooms		▲	●	▲	●	▲	▲	●	●	●	●	▲	▲	▲	▲	▲	▲	▲
Classification based on inspection results for the latest one year (from April 1, 2016, to February 28, 2017)																		
●: Items wherein radioactivity concentrations exceeding the standard limits were detected (for fishery products, those wherein radioactivity concentrations exceeding half of the standard limits were detected)																		
●: Items wherein radioactivity concentrations exceeding half of the standard limits were detected (excluding those wherein radioactivity concentrations exceeding the standard limits were detected)																		
□: Items requiring inspections in consideration of the difficulties in management (wild mushrooms and wild plants), the mobility (wild bird and animal meat), or the status of distribution restrictions (marine fish)																		
▲: Items requiring cultivation management and monitoring based on the influence of radioactive materials on materials used for production																		
—: Items that are not classified by relevant prefectures as those requiring inspections based on inspection results for the latest one year																		
×: Nothing applicable																		
Prepared based on the Ministry of Health, Labour and Welfare's website, "Measures for Radioactive Materials in Foods"																		

In FY2016, more than five years after the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS, radioactivity concentrations had decreased as a whole and food items with radioactivity concentrations exceeding the standard limits had become limited. Therefore, the national government reviewed inspection methods to make them more reasonable and efficient by reconsidering prefectures to be inspected, while ascertaining opinions of consumers and other related parties.

Based on the results of such review, inspections were streamlined centered on items whose cultivation/feeding is manageable to enhance efficiency. At the same time, as inspection results had been accumulated, the approach for deciding prefectures and items to be inspected and lifting distribution restrictions was reviewed and inspection targets are as shown in the table above as of FY2017.

With regard to items for which cultivation/feeding management is difficult, prefectures where inspections need to be continued are specified for each item in consideration of the difficulties in management thereof.

With regard to log-grown mushrooms, prefectures where inspections need to be continued are also specified considering the influence of radioactive materials on materials used for production.

Included in this reference material on February 28, 2018

## Prefectures and Food Items to be Inspected (Items whose Cultivation/Feeding is Manageable (excl. Log-grown Mushrooms))

Food items whose cultivation/feeding is manageable (excl. log-grown mushrooms) and relevant prefectures to be inspected

		Iwate	Miyagi	Fukushima	Tochigi
Items with radioactivity concentrations exceeding half of the standard limits but not exceeding the standard limits	Vegetables	—	—	●	—
	Fruits	—	—	●	—
	Beans	—	—	●	—
	Meat	—	●	●	—
Rice		—	—	■	—
Soybeans		—	—	■	—
Buckwheat		■	—	—	—

\* Items requiring continued monitoring as being significantly affected by feeding management (milk and beef meat) are inspected in Iwate, Miyagi, Fukushima, Tochigi and Gunma Prefectures.

Classification based on inspection results for the latest one year (from April 1, 2016, to February 28, 2017)

- : Items wherein radioactivity concentrations exceeding half of the standard limits were detected (excluding those wherein radioactivity concentrations exceeding the standard limits were detected)
- : Items that are classified as inspection targets in the Appendix
- : Items that are not classified by relevant prefectures as those requiring inspections based on inspection results for the latest one year

Prepared based on the Ministry of Health, Labour and Welfare's website, "Measures for Radioactive Materials in Foods" 厚生労働省

With regard to items whose cultivation/feeding is manageable (excluding log-grown mushrooms), prefectures where inspections need to be continued are specified for each item based on inspection results for the latest three years, such as prefectures where items with radioactive cesium exceeding half of the standard limits were detected.

In other prefectures, inspections are to be conducted as needed.

Included in this reference material on February 28, 2018

Measures for  
Radioactive  
Materials in Foods

Concepts of Inspection Planning and Establishment and Cancellation  
of Items and Areas to which Restriction of Distribution and/or  
Consumption of Foods Concerned Applies

	Local governments marked with ◎ and ○ (those marked with ■ and ▲ should conduct inspections correspondingly)	
	Municipalities (exceeding half of the standard limits)	Other municipalities
Exceeding half of the standard limits	3 or more samples	1 or more samples* <sup>1</sup>
Beef meat	Once every three months for each farm household* <sup>2</sup>	
Milk	Periodically for each cooler station* <sup>3</sup>	
Inland water fish Marine fish	Periodically* <sup>4</sup>	

\*1: It is permissible to divide a prefecture into multiple zones across municipalities and conduct inspections for three or more samples in each of those zones.

\*2: For farm households whose feeding management has been recognized as appropriate by the relevant local government, it would suffice to conduct inspections once every 12 months or so.

\*3: This does not apply in cases where the relevant local government recognizes appropriate feeding management and there are no areas subject to distribution restrictions for raw milk and where inspection results for the latest three years are all below half of the standard limits.

\*4: Inspections of marine fish by Iwate Prefecture are to be conducted in consideration of the past inspection results.

(For marks, ◎, ○, ■ and ▲, refer to p.52 and p.53 of Vol. 2, "Prefectures and Food Items to be Inspected")

Prepared based on the Ministry of Health, Labour and Welfare's website, "Measures for Radioactive Materials in Foods"

厚生労働省

This table shows the required number of samples and frequencies of inspections for local governments whose inspections detected radioactive cesium concentrations exceeding the standard limits (those marked with ◎) and local governments whose inspections detected radioactive cesium concentrations exceeding half of the standard limits (those marked with ○).

The "Concepts of Inspection Planning and Establishment and Cancellation of Items and Areas to which Restriction of Distribution and/or Consumption of Foods Concerned Applies" (March 24, 2017) by the Nuclear Emergency Response Headquarters specifies as follows.

"Regarding local governments that have detected radioactive cesium concentrations exceeding half of the standard limits in any food under this food classification since April 2016, inspections should be conducted for three or more samples for each municipality in the areas where radioactive cesium concentrations exceeding half of the standard limits were detected (marked with ◎ in the table). In other areas (marked with ○ in the table), inspections should be conducted for one or more samples for each municipality (it is permissible to divide a prefecture into multiple zones across municipalities and conduct inspections for three or more samples in each of those zones).

Included in this reference material on March 31, 2013

Updated on February 28, 2018

**Inspections are to be conducted combining a rigorous inspection (i) and an efficient screening test (ii).**

- (i) Radionuclide analysis using germanium semiconductor detectors
- (ii) Screening by measurement of radioactive cesium using NaI scintillation spectrometers

← Introduced to inspect a larger number of samples in a short time

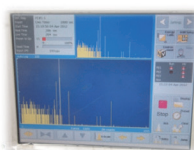
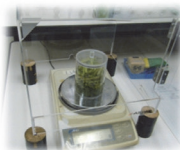
**< Procedures >**

**Shredding**

**Weighing**

**Measurement**

**Analysis**



Prepared based on the Ministry of Health, Labour and Welfare's website, "Measures for Radioactive Materials in Foods"



This figure shows procedures for inspections of radioactive materials in foods.

There are two ways to inspect foods, i.e., a rigorous inspection and an efficient screening test.

As a rigorous inspection, radionuclide analysis is conducted using a germanium semiconductor detector. After shredding a food sample, its weight is measured accurately. Then, the shredded sample is put in a prescribed container. The container is set in a detector, which is structured like a box covered with a thick layer of lead, and the amount of radioactive cesium is measured. Lastly, measurement results are analyzed.

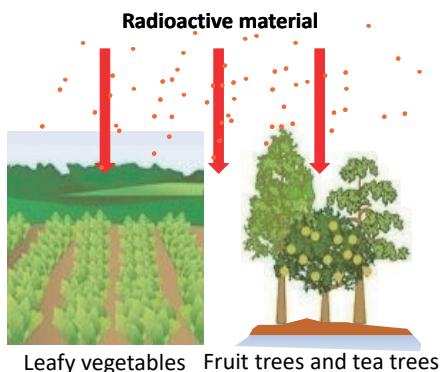
For an efficient screening test, a NaI (TI) scintillation spectrometer is used. A NaI scintillation spectrometer is inferior to a germanium semiconductor detector in terms of measurement accuracy, but can shorten the time required for inspections and is less expensive. If the measurement using a NaI scintillation spectrometer suggests the existence of radioactive cesium exceeding the standard limits, an inspection is conducted again using a germanium semiconductor detector.

Included in this reference material on March 31, 2013

Updated on March 31, 2017

## Contamination Routes for Agricultural Products

Direct contamination due to radionuclide fallout (immediately after the accident)

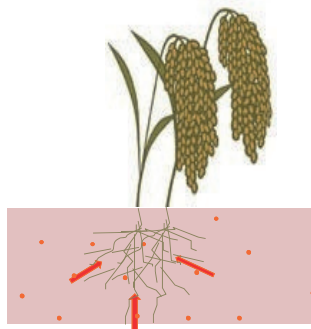


Leafy vegetables

Fruit trees and tea trees

Radioactive materials adhering to trees translocate to fruits or shoots.

Radioactive materials that fell onto soil are absorbed into crops from the roots.



Radioactive materials

Prepared based on the "Responses at Farmland" by the Ministry of Agriculture, Forestry and Fisheries (MAFF)

MAFF

Contamination routes due to radioactive fallout are roughly divided into three.

- (i) The figure on the left shows the route of how radioactive fallout directly adheres to crops. High radioactivity concentrations were often detected in leafy vegetables that were grown in the fields at the time of the accident. This is considered to be due to direct contamination.
- (ii) The figure in the center shows the route of how radioactive materials that adhered to fruit trees and tea trees immediately after the accident penetrate into trees and translocate\* to fruits and tea shoots.
- (iii) The figure on the right shows the route of how radioactive materials that fell onto soil are absorbed into crops from the roots. Contamination of crops planted after the accident is considered to have followed this route.

\* Translocation: Phenomenon wherein nutrients absorbed in a plant or metabolites produced by photosynthesis are transported from one tissue to another tissue  
(Related to p.171 of Vol. 1, "Transfer to Plants")

Included in this reference material on March 31, 2013

Updated on March 31, 2017

**Stripping of topsoil  
(Topsoil removal)**

Scrape away the topsoil to remove radioactive materials which remain in shallow depth

**Inversion tillage**

Replace topsoil with subsoil, thereby reducing radioactivity concentrations in the soil layer where plants take root



Prepared based on the "Responses at Farmland" by the Ministry of Agriculture, Forestry and Fisheries (MAFF)

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Radioactive materials that were released into the air and fell onto uncultivated farmland stay on topsoil.

Therefore, at farmland where high radioactivity concentrations are detected, the topsoil is scraped away to remove radioactive materials which remain in shallow depth.

In the meantime, at farmland where detected radioactivity concentrations are relatively low, topsoil is replaced with subsoil (inversion tillage) to reduce radioactivity concentrations in the soil layer where plants take root.

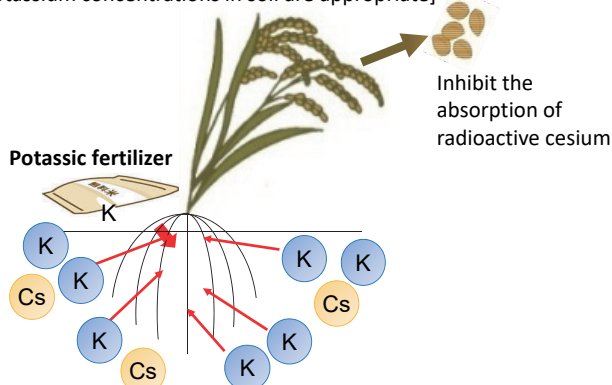
In this manner, efforts have been made to reduce radiation doses released from farmland and inhibit growing crops from absorbing radioactive materials.

Included in this reference material on March 31, 2013

Updated on March 31, 2017

- In paddy fields where detected radioactive cesium concentrations in brown rice are higher, potassium concentrations in soil tend to be lower.
- Potassium in soil has similar chemical characteristics as cesium and proper use of potassic fertilizer can inhibit growing crops from absorbing cesium.

[When potassium concentrations in soil are appropriate]



Prepared based on the "Inspection Results Concerning Radioactive Materials in Foods" by the  
Ministry of Agriculture, Forestry and Fisheries (MAFF)

MAFF

It is known that crops, such as rice, absorb more radioactive cesium when potassium concentrations in soil are lower.

Potassium and cesium have similar chemical characteristics, and when the soil contains sufficient potassium, less cesium is absorbed into crops.

Therefore, at farmland where potassium concentrations in soil are low, a sufficient amount of potassic fertilizer is applied to increase potassium concentrations above a certain level to inhibit absorption of radioactive cesium into crops.

Included in this reference material on March 31, 2013

Updated on March 31, 2017

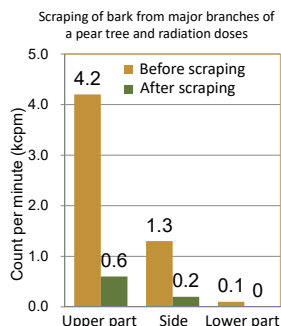


**Wash off radioactive cesium adhering to trees with high-pressure water and scrape away bark to reduce radioactive cesium concentrations**

**High-pressure washing  
of a persimmon tree**



**Scraping of bark from a  
pear tree**



Prepared based on the "Inspection Results Concerning Radioactive Materials in Foods" by the Ministry of Agriculture, Forestry and Fisheries (MAFF)

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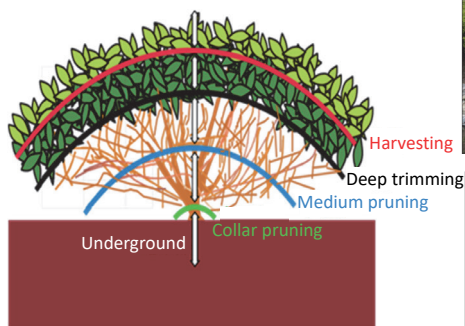
In order to prevent translocation of radioactive materials from fruit trees to fruits, trees are washed with high-pressure water and bark is scraped off from trees to remove adhering radioactive materials.

In the case of pear trees, there is data that radiation doses from major branches are reduced by nearly 90% by scraping off the bark.

Included in this reference material on March 31, 2013

Updated on March 31, 2017

**Reduce transfer of radioactive cesium from leaves and trees to new leaves by pruning and deep trimming**



Prepared based on the "Inspection Results Concerning Radioactive Materials in Foods" by the Ministry of Agriculture, Forestry and Fisheries (MAFF)

MAFF

In the case of tea trees, in order to prevent transfer of radioactive materials from the surface of leaves to new leaves, leaves and branches are trimmed or pruned deeper than usual to remove contaminated parts.

Included in this reference material on March 31, 2013

Updated on March 31, 2017

- In order to prevent farmland soil from being contaminated with radioactive cesium, the reference value of 400 Bq/kg in fertilizers, soil amendments and soils for cultivation was set.<sup>(\*)</sup>
- Several local governments and other organizations have conducted inspections and imposed a voluntary ban or other measures for reduction of radioactive cesium on fertilizers and materials in which radioactive cesium concentration exceeded the reference value.

\* The reference value was set so as not to exceed the normal range of radioactive cesium concentration in soil before the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS, even with continuous application of these agricultural materials for long periods.

Prepared based on the "Responses at Farmland" by the Ministry of Agriculture, Forestry and Fisheries (MAFF)

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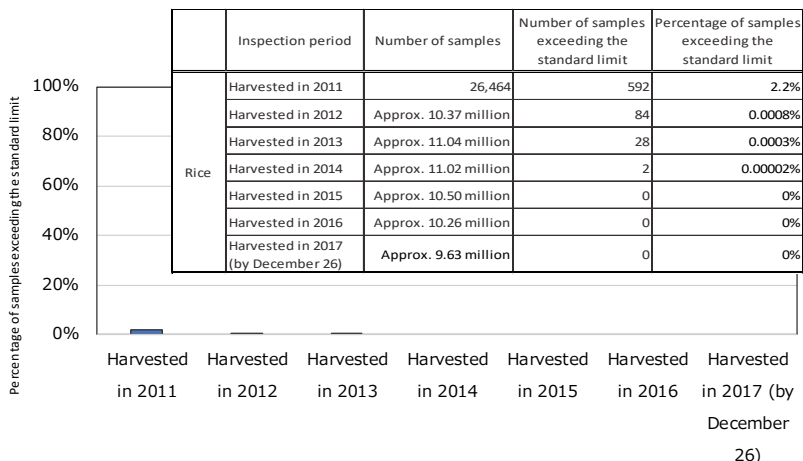
Regarding materials used for agricultural production, such as fertilizers, soil amendments and soils for cultivation, the reference value of 400 Bq/kg was set in order to prevent expansion of contamination of farmland soil by use of materials contaminated with radioactive cesium.

Several local governments and other organizations have monitored radioactive cesium concentration in these materials, and provide guidance to ensure that materials containing radioactive cesium exceeding the reference value should not be used at farmland.

Included in this reference material on March 31, 2013

Updated on March 31, 2017

## Changes in Inspection Results for Rice (Incl. Inspection of All Rice Bags)



\* Coverage: 17 prefectures including the Tokyo Metropolis designated as inspection targets in the "Concepts of Inspection Planning and Establishment and Cancellation of Items and Areas to which Restriction of Distribution and/or Consumption of Foods Concerned Applies," which compiles basic approaches concerning radioactive materials in foods

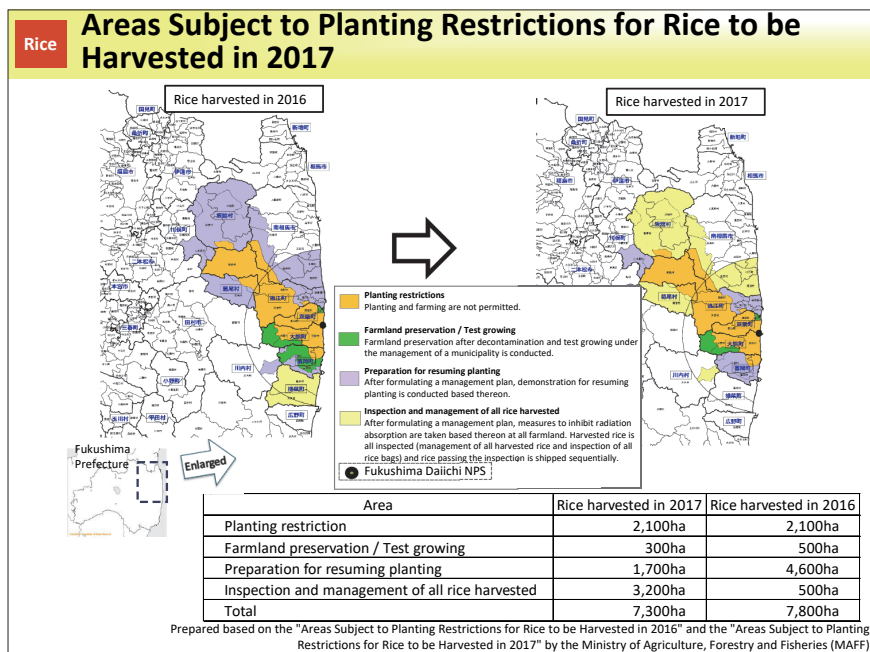
Prepared based on the "Inspection Results Concerning Radioactive Cesium Concentrations in Agricultural Products" by the Ministry of Agriculture, Forestry and Fisheries and the "Inspection Results Concerning Radioactive Materials in Foods" by the Ministry of Health, Labour and Welfare

The production and distribution of rice are managed through measures to inhibit radioactive cesium absorption by the use of potassic fertilizer and inspection of all bags of harvested rice. In Fukushima Prefecture, planting has been restricted and measures to inhibit radioactive cesium absorption have been taken at Areas under Evacuation Orders and distribution of rice has been strictly controlled through inspection of all rice bags since FY2015 based on the "Policies on Planting of Rice."

Rice containing radioactive cesium at a level exceeding the standard limit decreased year by year, and there has been none since FY2015 (as of December 26, 2017).

Included in this reference material on March 31, 2014

Updated on February 28, 2018



Entry and farming are restricted in Areas under Evacuation Orders. In Habitation Restricted Areas, farmland preservation after decontamination and test growing under the management of the relevant municipalities may be conducted, and in Preparation Areas for Lift of Evacuation Order, demonstration for resuming planting may be conducted under a management plan formulated by the prefecture and the relevant municipalities (preparation for resuming planting).

In areas not subject to evacuation orders that were under evacuation orders in the previous year or where rice containing radioactive cesium exceeding the standard limit was detected in the previous year, the prefecture and the relevant municipalities formulate a management plan and measures to inhibit radioactive cesium absorption are taken thoroughly and all rice harvested in respective areas is managed and all bags are inspected (inspection and management of all rice harvested).

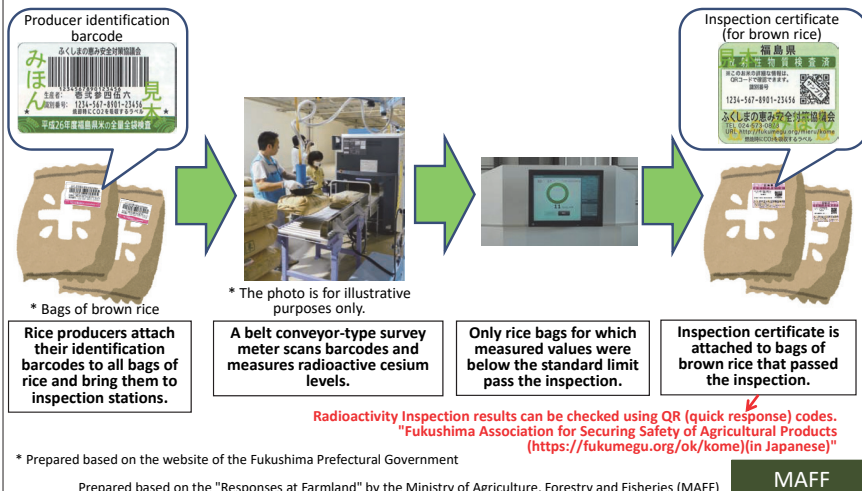
In areas where inspection and management of all rice harvested were obliged in the previous year and there was none harvested in the previous year wherein radioactive cesium exceeding the standard limit was detected, measures to inhibit radioactive cesium absorption are taken thoroughly by each farm household and all farm households are inspected (inspection and management of all farm households).

In other areas, measures to inhibit radioactive cesium absorption are taken as needed and random inspection is conducted for each area.

Included in this reference material on February 28, 2018

## Radioactivity Inspection of All Rice Bags by Fukushima Prefecture

**Fukushima Prefecture has been inspecting all bags of rice harvested throughout the prefecture since 2012, apart from inspections based on the inspection guideline.**



Since 2012, Fukushima Prefecture has been inspecting all bags of rice harvested throughout the prefecture, not limited to the areas instructed by the national government, as an initiative by the prefecture. For radioactivity inspections, belt conveyor-type survey meters are used.

Whether the rice has passed the inspection can be checked as follows. In the case of brown rice packed in a 30-kg paper bag that passed the inspection, an inspection certificate is attached to the paper bag.

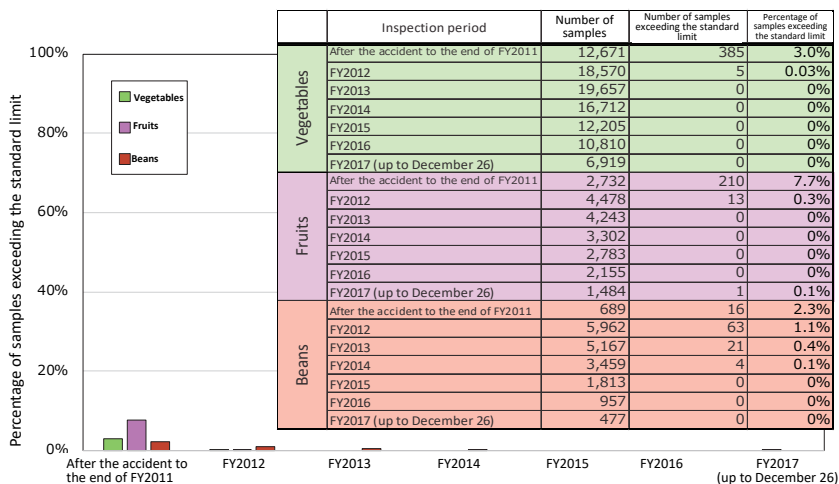
In the case of polished rice, a polished rice label to prove that it is made from brown rice that passed the inspection is attached. However, as this label is attached on a voluntary basis, some polished rice that passed the inspection may be distributed without the label.

(Cited from the website of Fukushima Prefecture "Frequently Asked Questions about Radioactivity Inspection of All Rice Bags": <http://www.pref.fukushima.lg.jp/sec/36035b/suiden-zenryozenhukurokensa-faq.html>, in Japanese)

Included in this reference material on March 31, 2013

Updated on February 28, 2018

# Changes in Inspection Results for Vegetables, Fruits and Beans



\* Coverage: 17 prefectures including the Tokyo Metropolis designated as inspection targets in the "Concepts of Inspection Planning and Establishment and Cancellation of Items and Areas to which Restriction of Distribution and/or Consumption of Foods Concerned Applies," which compiles basic approaches concerning radioactivity in foods. Values for beans are those compiled based on production years.

Prepared based on the "Inspection Results Concerning Radioactive Cesium Concentrations in Agricultural Products" by the Ministry of Agriculture, Forestry and Fisheries and the "Inspection Results Concerning Radioactive Materials in Foods" by the Ministry of Health, Labour and Welfare

Upon production and shipment of vegetables, fruits and beans, measures to inhibit radioactive cesium absorption by the use of potassic fertilizer are taken.

No vegetables and beans harvested in FY2015 onward have been found to contain radioactive cesium exceeding the standard limit up to December 2017.

No fruits harvested in FY2013 through to FY2016 were found to contain radioactive cesium exceeding the standard limit, but there was one case where radioactive cesium exceeding the standard limit was detected among fruits harvested in FY2017 (as of December 2017).

Included in this reference material on February 28, 2018

**Ensuring safety through**

- (i) thorough feeding management in line with the new standard limits,**
- (ii) testing of radioactive cesium, and**
- (iii) restriction of distribution according to testing results**

Prepared based on the "Responses at Farmland" by the Ministry of Agriculture, Forestry and Fisheries (MAFF)

MAFF

Measures for reducing radionuclides in livestock products include (i) thorough feeding management, such as feeding livestock with safe feed, (ii) testing of radioactive cesium before shipment, and (iii) restriction of distribution according to testing results. Through these measures, safety of livestock products has been ensured.

Included in this reference material on March 31, 2013



## Feed Management (1/2)

The reference values for feed were established in order to prevent distribution of any livestock products with radioactivity concentrations exceeding the standard limits (100 Bq/kg for general foods and 50 Bq/kg for milk).

	Reference value (Bq/kg)
<b>Cattle</b>	<b>100</b>
<b>Pigs</b>	<b>80</b>
<b>Chickens</b>	<b>160</b>
<b>(Cultured fish</b>	<b>40 )</b>

Prepared based on the "Responses at Farmland" by the Ministry of Agriculture, Forestry and Fisheries (MAFF)

MAFF

The reference values were established for feed so that livestock products would not contain radioactive cesium exceeding the standard limits.

Also for feed for cultured fish, the reference value was established in the same manner.

Included in this reference material on December 1, 2015

Updated on March 31, 2017

1. Thorough implementation of feeding management, including feeding forage (grass, hay, etc.) whose radiation levels are below the reference values

and

2. Promotion of decontamination measures including inversion tillage in pastures where production of grass whose radiation levels are below the reference values is difficult



Prepared based on the "Responses at Farmland" by the Ministry of Agriculture, Forestry and Fisheries (MAFF)

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On farms, thorough implementation of feeding management, including feeding forage whose radiation levels are below the reference values is ensured.

In pastures, efforts to produce forage crops whose radiation levels are below the reference values by decontamination measures, including inversion tillage, are making progress (p.57 of Vol. 2, "Measures for Reducing Transfer of Radioactive Materials to Crops (1/5) - Decontamination of Farmland -").

Included in this reference material on December 1, 2015

Updated on March 31, 2017

**(i) Beef**

Five prefectures (Iwate, Miyagi, Fukushima, Tochigi and Gunma) inspect beef once every three months or so for each farm household. However, for farm households whose proper feeding management was confirmed by relevant local governments, inspections are conducted once every 12 months or so.

**(ii) Milk**

Five prefectures (Iwate, Miyagi, Fukushima, Tochigi and Gunma) inspect milk periodically at least once every two weeks. However, this does not apply in cases where a local government recognizes appropriate feeding management and there are no areas subject to distribution restrictions for raw milk and where inspection results for the latest three years are all below half of the standard limits.

Prepared based on the "Responses at Farmland" by the Ministry of Agriculture, Forestry and Fisheries (MAFF) and the "Concepts of Inspection Planning and Establishment and Cancellation of Items and Areas to which Restriction of Distribution and/or Consumption of Foods Concerned Applies" (March 24, 2017) by the Nuclear Emergency Response Headquarters

MAFF

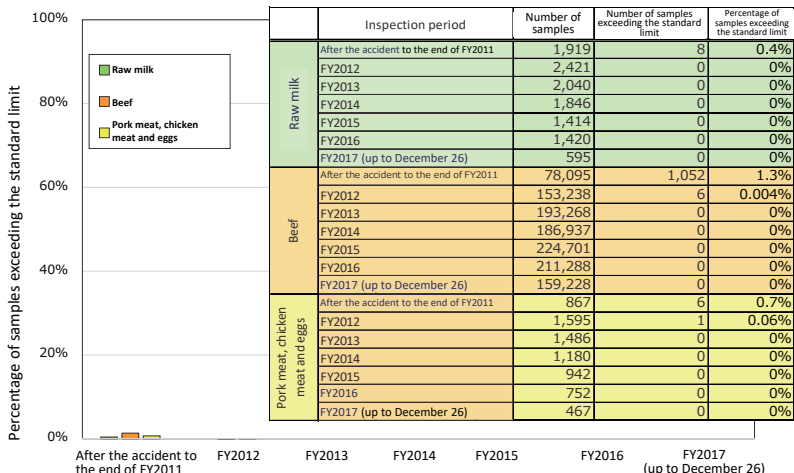
For beef, five prefectures (Iwate, Miyagi, Fukushima, Tochigi and Gunma) conduct inspections covering all relevant farm households.

Milk is also inspected periodically by these five prefectures.

Included in this reference material on March 31, 2013

Updated on February 28, 2018

# Changes in Inspection Results for Livestock Products



\* Coverage: 17 prefectures including the Tokyo Metropolis designated as inspection targets in the "Concepts of Inspection Planning and Establishment and Cancellation of Items and Areas to which Restriction of Distribution and/or Consumption of Foods Concerned Applies," which compiles basic approaches concerning radioactive materials in foods

Prepared based on the "Inspection Results Concerning Radioactive Cesium Concentrations in Livestock Products" by the Ministry of Agriculture, Forestry and Fisheries and the "Inspection Results Concerning Radioactive Materials in Foods" by the Ministry of Health, Labour and Welfare

Feed for livestock is controlled to reduce radionuclides contained therein as low as possible.

## Reference values for radioactive cesium in feed

Feed for cattle and horses: 100 Bq/kg

Feed for pigs: 80 Bq/kg

Feed for chickens: 160 Bq/kg

Feed for cultured fish: 40 Bq/kg

Since April 2011, inspection results for raw milk have all been below 50 Bq/kg. Regarding beef, pork meat, chicken meat and eggs, radioactive cesium concentrations exceeding the standard limit have not been detected since FY2013.

Raw milk is inspected for each cooler station, while beef is inspected covering all relevant farm households once every three months in Iwate, Miyagi, Fukushima, Tochigi and Gunma Prefectures.

Included in this reference material on February 28, 2018

- ❑ Introduce safe production materials in order to reduce radioactive contamination
- ❑ Provide information on gathering of wild plants and mushrooms

**Specific measures**

1. Secure safe mushroom logs  
(Support for the purchase of mushroom logs and bed logs, matching of supply and demand of mushroom logs)
2. Decontaminate mushroom logs and bed logs and introduce makeshift greenhouses, etc.
3. Disseminate cultivation management in line with the guideline and give guidance therefor
4. Disseminate cultivation technology to reduce radioactive contamination
5. Provide information using the website and pamphlets and conduct guidance tours



Prepared based on the "Inspection Results Concerning Radioactive Materials in Foods" by the Ministry of Agriculture, Forestry and Fisheries (MAFF)

MAFF

Other than wild plants and mushrooms for which cultivation management is impossible, *shiitake* mushrooms, etc. cultivated using mushroom logs show variation in radioactivity concentrations.

Therefore, efforts are being made, such as the offering of support for the purchase of safe mushroom logs and measures to reduce contamination of mushroom logs and bed logs (mushroom logs wherein mushroom fungi are planted).

In order to prevent distribution of wild plants and mushrooms with radioactivity concentrations exceeding the standard limit, each local government imposes distribution restrictions on producers and farmers markets and provides them with inspection results or other information.

Included in this reference material on March 31, 2013

Updated on March 31, 2017

**(Reference) Provisional Safety Standards for  
Mushroom Logs, etc.**

- Mushroom logs and beds may be distributed nationwide.
- In order to ensure the safety of supplied mushrooms, provisional safety standards for mushroom logs and beds were established.

**Provisional safety standards (from April 2012)**

Mushroom logs and bed logs	50 Bq/kg
Culture media for beds and mushroom beds	200 Bq/kg

Bed logs: Mushroom logs wherein mushroom fungi are planted

Mushroom beds: Culture media mixed with sawdust and nutrients wherein mushroom fungi are planted

Prepared based on the "Responses at Farmlands" by the Ministry of Agriculture, Forestry and Fisheries (MAFF)

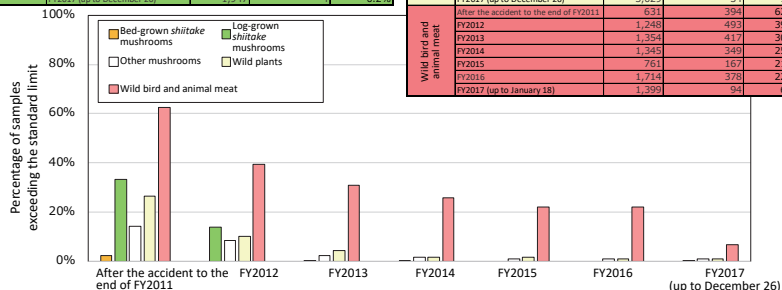
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Mushroom logs and beds may be distributed nationwide in the same manner as livestock feeds. Therefore, in order to cultivate safe mushrooms, provisional safety standards were set at 50 Bq/kg for mushroom logs and bed logs and at 200 Bq/kg for mushroom beds, and they are managed properly so that contained radioactive materials do not exceed those standards.

Included in this reference material on March 31, 2013

Updated on March 31, 2017

	Inspection period	Number of samples	Number of samples exceeding the standard limit	Percentage of samples exceeding the standard limit
Bed-grown shiitake mushrooms	After the accident to the end of FY2011	358	9	2.5%
	FY2012	868	0	0%
	FY2013	869	0	0%
	FY2014	830	0	0%
	FY2015	754	0	0%
	FY2016	617	0	0%
	FY2017 (up to December 26)	435	0	0%
Log-grown shiitake mushrooms	After the accident to the end of FY2011	1,093	364	33.3%
	FY2012	1,513	213	14.1%
	FY2013	1,298	2	0.2%
	FY2014	1,996	3	0.2%
	FY2015	2,139	0	0%
	FY2016	2,362	0	0%
	FY2017 (up to December 26)	1,947	4	0.2%
Other mushrooms	After the accident to the end of FY2011	1,881	268	14.2%
	FY2012	2,257	195	8.6%
	FY2013	2,230	50	2.2%
	FY2014	2,169	38	1.8%
	FY2015	2,117	24	1.1%
	FY2016	2,084	23	1.1%
	FY2017 (up to December 26)	1,641	16	1.0%
Wild plants	After the accident to the end of FY2011	524	138	26.3%
	FY2012	1,950	197	10.1%
	FY2013	3,184	142	4.5%
	FY2014	3,562	62	1.7%
	FY2015	3,423	63	1.8%
	FY2016	4,178	46	1.1%
	FY2017 (up to December 26)	3,029	34	1.1%
Wild bird and animal meat	After the accident to the end of FY2011	631	394	62.4%
	FY2012	1,248	493	39.5%
	FY2013	1,354	417	30.8%
	FY2014	1,345	349	25.9%
	FY2015	761	167	21.9%
	FY2016	1,714	378	22.1%
	FY2017 (up to January 18)	1,399	94	6.7%



\* Coverage: 17 prefectures including the Tokyo Metropolis designated as inspection targets in the "Concepts of Inspection Planning and Establishment and Cancellation of Items and Areas to which Restriction of Distribution and/or Consumption of Foods Concerned Applies," which compiles basic approaches concerning radioactive materials in foods

Prepared based on the "Inspection Results Concerning Radioactive Cesium Concentrations in Agricultural Products" by the Ministry of Agriculture, Forestry and Fisheries and the "Inspection Results Concerning Radioactive Materials in Foods" by the Ministry of Health, Labour and Welfare

Regarding mushrooms, thanks to efforts for securing safe logs and the introduction of makeshift greenhouses, etc., radioactive contamination has been reduced through the use of production materials in conformity to the standards. The percentage of mushrooms with radioactive concentrations exceeding the standard limit is decreasing.

■ Provisional safety standards for mushroom logs, bed logs, culture media for beds and mushroom beds

Mushroom logs and bed logs: 50 Bq/kg

Culture media for beds and mushroom beds: 200 Bq/kg

Radioactive concentrations exceeding the standard limit are still detected in some wild mushrooms and wild plants, for which cultivation management is impossible, although the number and percentage of samples exceeding the standard limit show declining trends. Therefore, their shipment is thoroughly controlled continuously.

Wild bird and animal meat, such as boar meat and deer meat, still show radioactive concentrations exceeding the standard limit. Feeding management like that for livestock animals is difficult for wild birds and animals that move around freely. Therefore, shipment of wild bird and animal meat is restricted by each prefecture in principle, and in some cases, only meat managed based on shipment and inspection policies formulated independently by respective local governments is permitted to be shipped out.

Included in this reference material on February 28, 2018

## Approach for Inspections of Fishery Products

### ○ Inspections were strengthened by increasing the fish species to be inspected and the inspection frequencies.

- The fish species in which radioactive cesium exceeding 50 Bq/kg has been detected and major fishery products are intensively inspected.
- Inspection results of neighboring prefectures are taken into account.

Coastal fish (e.g., Japanese sand lance, seabass, flounders, etc.)	Sea areas off prefectures are divided into zones in consideration of catch landing, fishery management and seasons, etc. and samples are collected at major ports. Samples are collected considering the habitats of fish such as surface layer, middle layer or bottom layer.
Migratory fish (e.g., Skipjack tuna, sardines and mackerels, Pacific saury, etc.)	Fishing grounds are divided into zones off each prefecture from Chiba to Aomori (by lines extending along the prefectural borders to the east) in consideration of migration of fish, etc., and samples are collected at major ports of each zone.
Inland water fish (e.g., YAMAME (land-locked cherry salmon), Japanese smelt, Ayu sweetfish, etc.)	Prefectural areas are divided into zones appropriately in consideration of fishery rights, and samples are collected in major zones.

Prepared based on the "Responses at Farmland" by the Ministry of Agriculture, Forestry and Fisheries (MAFF)

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Inspections of radioactivity in fishery products cover major fish species and fishing grounds, and species in which radioactive cesium exceeding 50 Bq/kg has been detected.

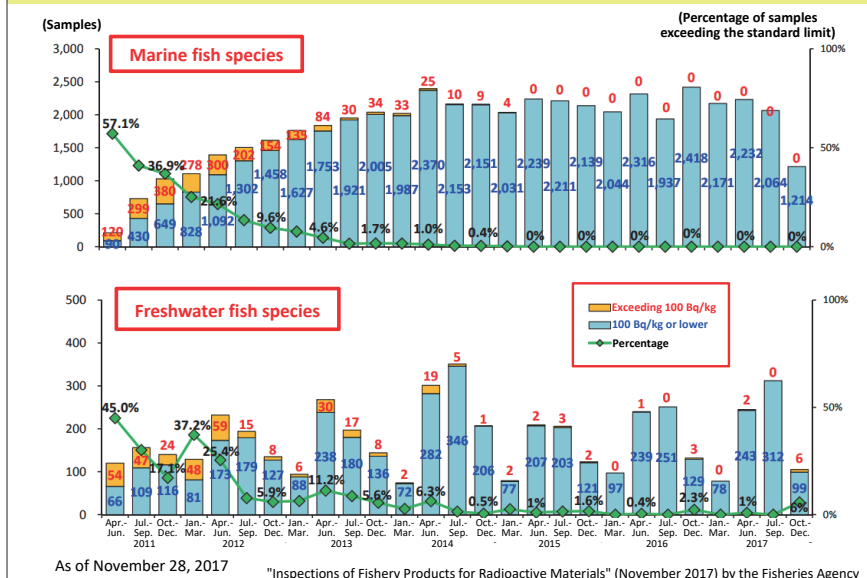
Analysis of accumulated inspection results, etc. has revealed that radioactive contamination levels differ depending on the habitats of relevant fish species, etc.

For example, contamination levels differ depending on whether the habitat is close to the sea surface, or the sea bottom, or in between. Therefore, inspections are conducted by classifying the fish species based on their habitats and fishing seasons, while also taking into account inspection results of neighboring prefectures. Regarding migratory fish, such as bonito and Pacific saury, which migrates over a wide area in the ocean, inspections are conducted broadly by multiple prefectures based on their migratory routes.

Included in this reference material on March 31, 2013

Updated on March 31, 2014



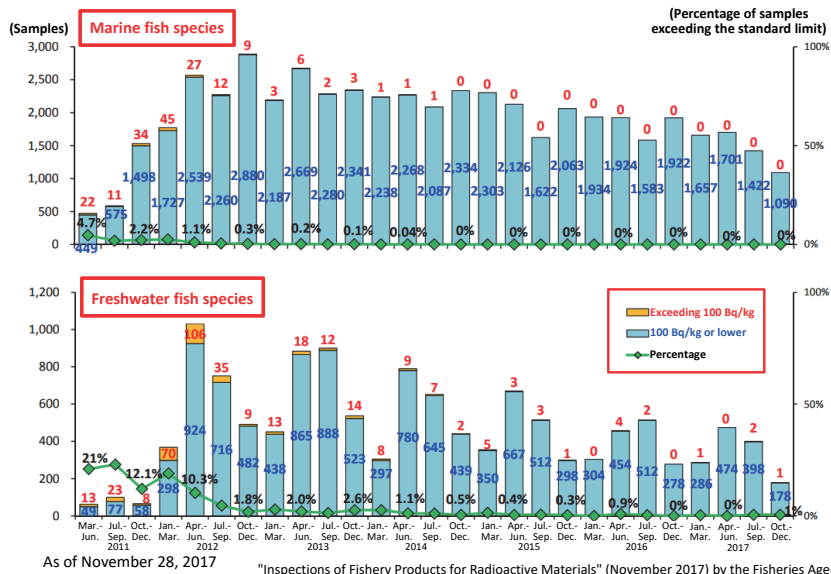


The percentage of samples exceeding the standard limit (100 Bq/kg) was 57% for marine fish and 45% for freshwater fish during the period from April to June 2011, but the percentage decreased by half in one year after the accident. Since April 2012, inspections have been focused on the fish species in which radioactive cesium concentrations exceeding 50 Bq/kg had been detected, and the percentage of samples with radioactive cesium concentrations exceeding the standard limit is continuing to decrease. There have been no such marine fish samples since FY2015, but some freshwater fish samples still show radioactive cesium concentrations exceeding the standard limit.

Included in this reference material on March 31, 2014

Updated on February 28, 2018

# Inspection Results for Fishery Products (Marine Fish Species Caught off the Coast of Prefectures Other than Fukushima Prefecture and Freshwater Fish Species Caught in Prefectures Other than Fukushima Prefecture)



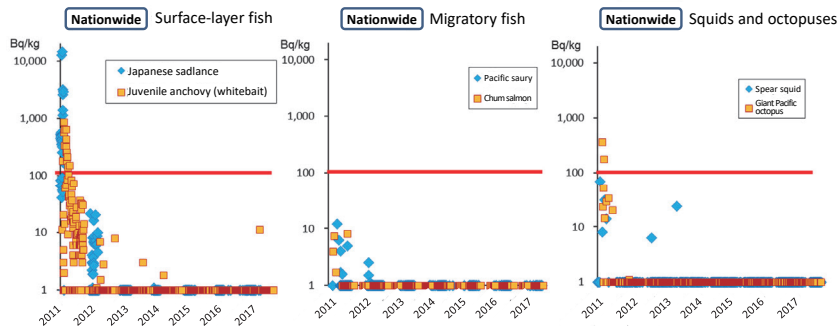
The percentage of samples with radioactive cesium concentrations exceeding the standard limit (100 Bq/kg) has also been decreasing among samples collected off or in prefectures other than Fukushima Prefecture. There have been no such marine fish samples since FY2015, but some freshwater fish samples still show radioactive cesium concentrations exceeding the standard limit.

Included in this reference material on March 31, 2014

Updated on February 28, 2018

## Trends of Radioactive Cesium Concentrations by Fish Species (1/2)

- At present, all samples of surface-layer fish, such as Japanese sand lance and whitebait, migratory fish such as bonito and tunas, chum salmon and Pacific saury, bottom fish such as flounders, flatfishes and cods, as well as squids and octopuses, shrimps and crabs, shellfish and seaweeds, show radioactive cesium concentrations below the standard limit in all prefectures.
- The environment of habitats and feeding habits correlate to changes in radioactive cesium concentrations in the respective groups of fish.



Results of inspections from March 24, 2011, to December 26, 2017, compiled by the Fisheries Agency

MAFF

The above figures show inspection results concerning radioactive cesium concentrations in fish by fish species with different habitats and feeding habits.

Japanese sand lance, whitebait and other species of surface-layer fish showed high radioactive cesium concentrations immediately after the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS, but radioactive cesium concentrations in samples of these fish species at present are all below the standard limit.

Regarding Pacific saury, chum salmon and others that migrate over a wide area in the ocean, radioactive cesium exceeding 100 Bq/kg or exceeding 50 Bq/kg was not detected at all even immediately after the accident.

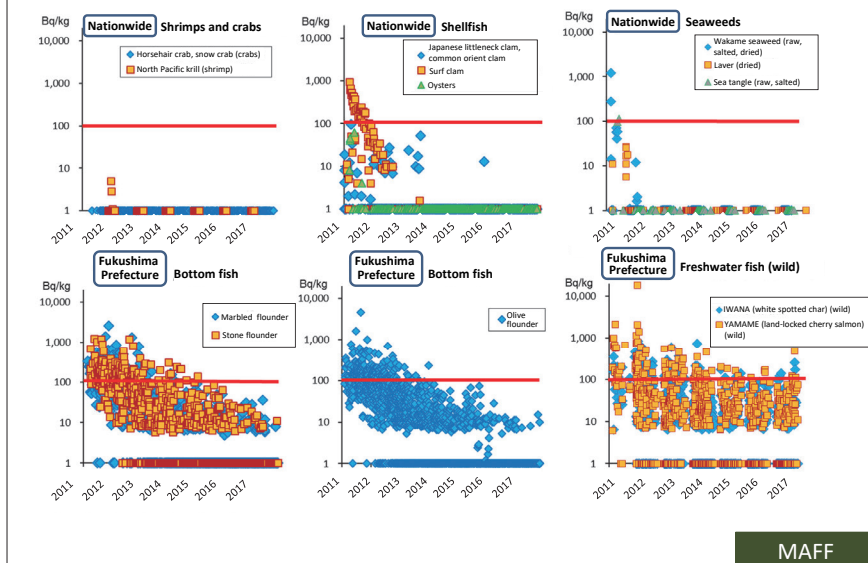
Marine invertebrates, such as squid and octopus, also showed high radioactive cesium concentrations immediately after the accident, but declines in radioactive cesium concentrations in samples of marine invertebrates were more prompt than in the case of surface-layer fish, and their radioactive cesium concentrations at present do not exceed even 50 Bq/kg. This is considered to be due to the nature of marine invertebrates through which ions freely move in and out to seawater. Due to this nature, radioactive cesium concentrations in marine invertebrates decrease according to radioactive cesium concentration decreases in seawater.

In this manner, the results of the past inspections show correlation between the environment of habitats and feeding habits and changes in radioactive cesium concentrations in the respective groups of fish.

Included in this reference material on March 31, 2013

Updated on February 28, 2018

## Trends of Radioactive Cesium Concentrations by Fish Species (2/2)



MAFF

Inspections of shrimps and crabs (horsehair crab, snow crab and North Pacific krill) showed no results exceeding 100 Bq/kg even immediately after the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS. Most results were below the detection lower limit. Regarding shellfish (Japanese littleneck clam, common orient clam, surf clam, and oysters) and seaweeds (Wakame seaweed, laver and sea tangle), radioactive cesium exceeding the standard limit was detected in some samples immediately after the accident, but radioactive cesium concentrations decreased promptly thereafter. Radioactive cesium concentrations in samples of bottom fish (flatfish and flounders, etc.) caught off the coast of Fukushima Prefecture decreased over time and are all below the standard limit at present.

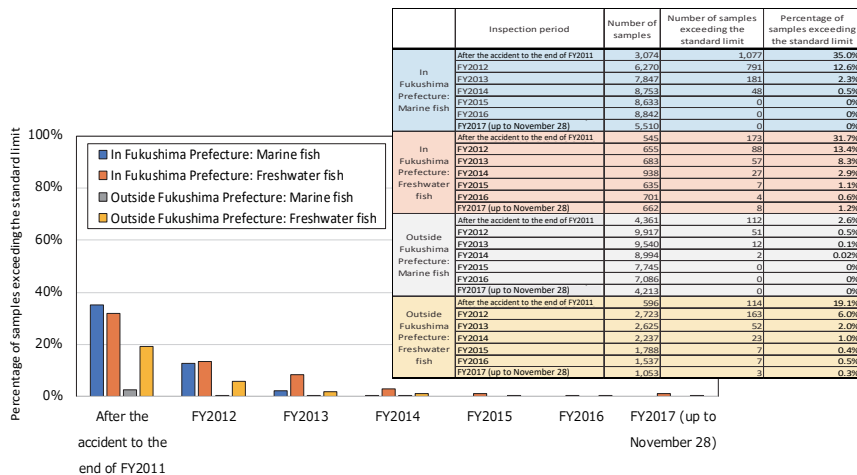
Inspection results for wild freshwater fish caught in Fukushima Prefecture (the figure right at the bottom) show that the percentage of samples in which radioactive cesium concentrations exceeded 100 Bq/kg was 51.3% in FY2011 but decreased as low as 1.4% in FY2016. Although some samples still show values exceeding 100 Bq/kg, but the percentage of samples exceeding the standard limit is decreasing over time.

(Prepared based on the "Inspections of Fishery Products for Radioactive Materials (December 2017)" on the website of the Fisheries Agency)

Included in this reference material on March 31, 2014

Updated on February 28, 2018

## Chronological Changes in Inspection Results for Fishery Products



\* Coverage: 17 prefectures including the Tokyo Metropolis designated as inspection targets in the "Concepts of Inspection Planning and Establishment and Cancellation of Items and Areas to which Restriction of Distribution and/or Consumption of Foods Concerned Applies," which compiles basic approaches concerning radioactive materials in foods

Prepared based on the "Inspections of Fishery Products for Radioactive Materials" (November 2017) by the Fisheries Agency

Inspections of fishery products have focused on the fishery products in which radioactive cesium concentrations exceeding 50 Bq/kg were detected in the previous fiscal year and major fishery products in relevant prefectures. Monitoring is conducted once a week or so in principle. The number of fishery product samples showing radioactive cesium concentrations exceeding the standard limit is decreasing gradually.

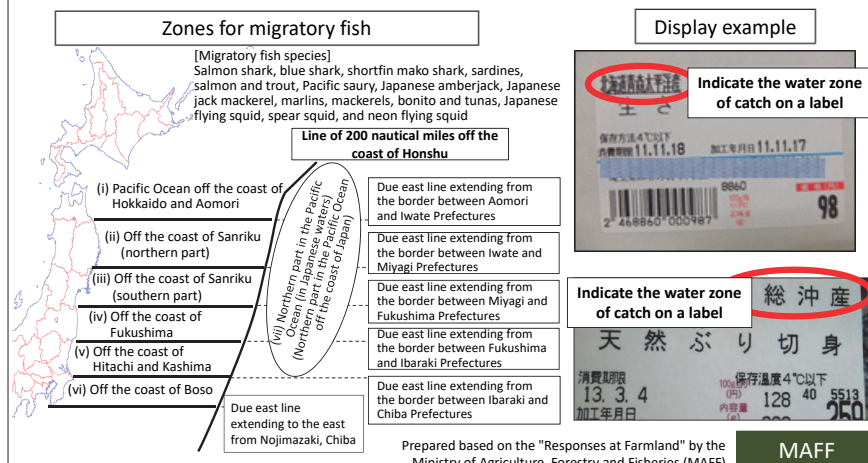
Analysis of inspection results revealed that radioactive cesium exceeding the standard limit was not detected in fish that migrate over a wide area in the ocean even immediately after the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS. Since FY2015, there have been no samples of marine fish species caught off the coast of Fukushima Prefecture and other prefectures that contained radioactive cesium exceeding the standard limit.

Some freshwater fish caught in and outside Fukushima Prefecture still show radioactive cesium concentrations exceeding the standard limit even in FY2017, but the number of such fish is decreasing year by year.

Included in this reference material on February 28, 2018

## Provision of Information on Place of Product Origin to Consumers

- Since October 2011, it has been recommended to display places of origin of fresh fishery products, mainly those caught on the Pacific side of eastern Japan, by dividing the sea areas into 7 zones and clarifying these zone names.



Since October 2011, the national government has been encouraging producers to display places of origin of fresh fishery products, mainly those caught on the Pacific side of eastern Japan so that consumers can easily understand where the relevant fishery product was caught. Related parties are providing consumers with information on inspections of fishery products for radioactive materials in an easy-to-understand manner, thereby striving to prevent harmful rumors.

Included in this reference material on March 31, 2013

# Import Restrictions by Other Countries Outline of Lifting and Easing of Food Import Restrictions by Other Countries after the Accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS

Food import restrictions by other countries (as of January 12, 2018)

Details of regulatory measures / Number of countries and regions			Countries and regions	
Imposed import restrictions after the accident:	Completely lifted regulatory measures: 26		Canada, Myanmar, Serbia, Chile, Mexico, Peru, Guinea, New Zealand, Colombia, Malaysia, Ecuador, Viet Nam, Iraq, Australia, Thailand, Bolivia, India, Kuwait, Nepal, Iran, Mauritius, Qatar, Ukraine, Pakistan, Saudi Arabia, Argentina	
	Continuing import restrictions:	Suspended import of items from some prefectures: 9	7	South Korea, China, Singapore, Hong Kong, Macao, Taiwan, Russia
			2	(Suspended import of items whose shipment is restricted in Japan) US, Philippines
		Requests issuance of inspection certificates for items from some or all prefectures: 17	Indonesia, Polynesia, Oman, Bahrain, Egypt, Congo, Morocco, Brazil, EU*, EFTA (Iceland, Norway, Switzerland, Liechtenstein), Brunei, New Caledonia, UAE, Lebanon * 28 EU member countries are collectively counted as one region.	
54	28	Strengthen inspections in the country: 2	Israel, Turkey	

Note 1) Classification in accordance with the details of the regulatory measures; Prefectures in Japan subject to respective regulatory measures differ by country or region.

Note 2) The government of Thailand lifted its regulatory measures but requests the issuance of inspection certificates for some wild animal meat

Examples of recent complete lifting of regulatory measures

Date of lifting	Countries
January 2014	Iraq
January 2014	Australia
May 2015	Thailand * Excluding some wild animal meat
November 2015	Bolivia
February 2016	India
May 2016	Kuwait
August 2016	Nepal
December 2016	Iran
December 2016	Mauritius
April 2017	Qatar
April 2017	Ukraine
October 2017	Pakistan
November 2017	Saudi Arabia
December 2017	Argentina

Examples of recent easing of import restrictions

Date of easing	Countries and regions	Major content
Apr., Jul., Aug. Sep. Oct. and Dec. 2016	US	Suspension of import (targeting Fukushima Prefecture, etc.) → Lifted import suspension for some items sequentially
June and September 2016	Polynesia	Decreased items and regions for which inspection certificates and certificates of origin are required (such as the exclusion of vegetables, fruits (except for persimmons), livestock products, buckwheat, tea, etc. produced in Fukushima Prefecture from items requiring inspection certificates) (September)
July 2016	Qatar	Inspection certificates (targeting all 47 prefectures) → Sample inspections at the time of import
July 2016	Israel	Decreased items and regions for which sample inspections at the time of import are required
October 2016	New Caledonia	Suspension of import (all foods and feed from 12 prefectures) → Lifted import suspension (attaching certificates is also no longer necessary for vegetables, fruits (except for persimmons), livestock products, buckwheat, tea, etc.)
December 2016	UAE	Decreased regions for which inspection certificates are required (all foods and feed from 15 prefectures → Targeted prefectures are now only five.)
March 2017	Lebanon	All foods and feed attached with inspection reports may be imported.
April 2017	Russia	Attaching an inspection certificate is no longer necessary for fishery products produced at facilities in Aomori Prefecture.
September and November 2017	US	• Safety certificates (concerning radioactive materials) at the time of import are no longer necessary for milk and dairy products from five prefectures including Fukushima. • Suspension of import (targeting Fukushima Prefecture, etc.) → Lifted import suspension for some items
January 2018	EU*	• Decreased items and regions for which inspection certificates and certificates of origin are required (such as the exclusion of rice, etc. from Fukushima Prefecture from items requiring inspection certificates)
December 2017	Turkey	Decreased items for which all for inspections at the time of import are required (exclusion of cut flowers and forssal plants, etc. from items requiring inspections)

\* EFTA member countries (Switzerland, Norway, Iceland, Liechtenstein) also eased regulations with reference to the EU.

MAFF

In response to the accident at TEPCO's Fukushima Daiichi NPS, countries and regions all over the world imposed various restrictions on imports from Japan. However, as a result of all-out efforts by the government of Japan, such regulatory measures have been lifted or eased. The number of countries or regions imposing restrictions has decreased from 54 immediately after the accident to 28.

Included in this reference material on February 28, 2018





# Chapter 9

Efforts toward Recovery from the Accident

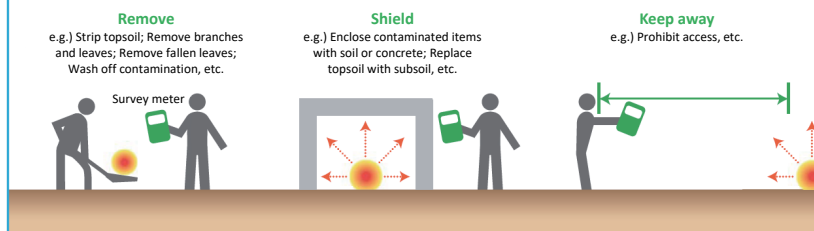


Purpose of  
Decontamination

## What is Decontamination?

Radioactive materials released into the air due to the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS fell onto the ground with rain, etc. and adhered to soil, vegetation, and buildings in people's living environment. Soil and vegetation, etc. thus contaminated are being removed through decontamination work. Removed soil and vegetation, etc. are shielded to prevent them from affecting the surroundings, thereby reducing radiation doses people receive from the environment.

## Methods of reducing radiation doses



Prepared based on the website, "Environmental Remediation," of the Ministry of the Environment

Radioactive materials released into the air due to the accident at TEPCO's Fukushima Daiichi NPS fell onto the ground with rain, etc. and adhered to buildings, soil, and vegetation, etc. across a wide area. Therefore, the national government has been striving to reduce additional exposure doses through decontamination such as removing those released radioactive materials.

There are three methods of reducing additional exposure doses to remove, to shield, and to keep away radioactive materials. Combination of these methods can reduce additional exposure doses efficiently.

The first is to remove radioactive materials adhering to soil, vegetation or buildings, etc. from people's living environment by such means as stripping topsoil, removing tree leaves, branches and fallen leaves, and washing and cleaning the surface of buildings.

The second is to cover radioactive materials with soil, etc. thereby shielding radiation and reducing ambient doses and exposure doses accordingly.

The third is to take advantage of the characteristic of radiation that the radioactivity intensity reduces as the distance increases (in inverse proportion to the square of the distance from the relevant radioactive material) (p.47 of Vol. 1, "Characteristics of External Exposure Doses").

If radioactive materials are kept away from people, exposure doses can be reduced. Therefore, one option is to prohibit access to places where radioactive materials exist.

At present, these methods are combined and employed to reduce people's additional exposure doses.

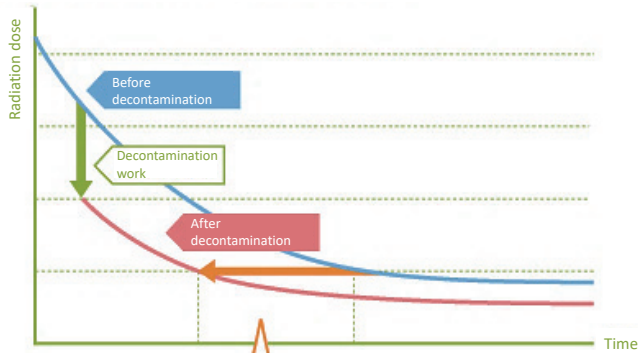
(Related to p.168 of Vol. 1, "Three Principles of Reduction of External Exposure")

Included in this reference material on March 31, 2013

Updated on February 28, 2018

## Decontamination and Decreases in Radiation Doses

### Decreases in doses of accident-derived radioactive materials



Compared with the level as of Aug. 2011, radiation doses naturally decreased by approx. 40% in two years and by approx. 60% in five years. Additionally, radiation doses can be reduced faster by removing radioactive materials through decontamination work.

Prepared based on the website, "Environmental Remediation," of the Ministry of the Environment

This is a conceptual figure showing decreases in doses of accident-derived radioactive materials.

Through decontamination work, radiation doses can be reduced faster, assisting the effects of physical attenuation of radioactive materials.

(Related to p.11 of Vol. 1, "Half-lives and Radioactive Decay")

Included in this reference material on March 31, 2014

Updated on January 18, 2016

# Decontamination Methods

Decontamination has been conducted in accordance with the circumstances of respective areas.  
Specific methods differ by location.

Effective methods differ depending on the status of contamination with radioactive materials. First, ambient dose rates are measured, and an optimal method is selected on a case-by-case basis. Radiation doses are measured before and after decontamination work to confirm the effects.



This figure explains specific decontamination methods.

Even in areas where radiation doses are relatively low, fallen leaves and dirt containing radioactive materials are apt to accumulate under the leaves or in gutters of houses or in ditches on the street, causing higher ambient doses in the surrounding areas. At such locations, fallen leaves and dirt are removed and the relevant places are washed and cleaned.

There are areas where radioactive materials adhere to the shrubbery, underbrush or fallen leaves. Radioactive materials are removed through mowing of vegetation, pruning and removal of fallen leaves.

In areas where radiation doses are relatively high, other decontamination methods, in addition to those employed at areas with relatively low radiation doses, may need to be employed. For example, as radioactive materials mostly exist within a layer a few centimeters below the ground surface, effects of radioactive materials can be mostly diminished by stripping topsoil (for example, to a depth of 5cm) or replacing topsoil with subsoil.

Areas where radioactive materials adhere to roofs and walls of buildings or on the paved road, relevant parts are washed and cleaned but such method may not be effective in cases where radioactive materials adhere firmly depending on the nature of their raw materials.

For farmland, proper methods need to be selected in consideration of the effects on agricultural products, as well as the effects on people due to exposure. In farmland plowed after the accident, radioactive materials exist little deeper from the ground surface. However, if all contaminated soil is removed, the farmland becomes unsuitable for farming. Therefore, at such farmland, various methods such as deep tillage (plowing soil as deep as 30 cm in principle) or inversion tillage (replacing topsoil with subsoil) (p.57 of Vol. 2, "Measures for Reducing Transfer of Radioactive Materials to Crops (1/5) - Decontamination of Farmland -") are being employed.

Included in this reference material on March 31, 2013

Updated on February 28, 2018

## Decontamination

# Special Decontamination Areas and Intensive Contamination Survey Areas

In line with the Act on Special Measures Concerning the Handling of Environment Pollution by Radioactive Materials enforced in full on January 1, 2012, and the Basic Policy based thereon, decontamination has been carried out. Areas especially necessary from the perspective of protecting human health were prioritized.

Soil, etc. removed through decontamination work is collected, transported to Temporary Storage Sites, and disposed of safely.

## Special Decontamination Areas

- Areas where the national government directly conducts decontamination work; Basically, 11 municipalities\* in Fukushima Prefecture which were once designated as a Restricted Area or a Deliberate Evacuation Area are designated.
- A decontamination plan should be formulated for each Special Decontamination Area, while taking into account respective municipalities' needs, and decontamination should be conducted in line with the plan.

\* The entire areas of Naraha Town, Tomioka Town, Okuma Town, Futaba Town, Namie Town, Katsurao Village and Iitate Village, and parts of Tamura City, Minamisoma City, Kawamata Town and Kawauchi Village which were once designated as a Restricted Area or a Deliberate Evacuation Area

## Intensive Contamination Survey Areas

- Areas where municipalities take the initiative in decontamination work; 92 municipalities in eight prefectures\* are designated as Intensive Contamination Survey Areas (as of the end of December 2017) from among municipalities including areas where measured ambient dose rates were 0.23  $\mu\text{Sv/h}$  or higher.
- Each municipality should carry out a measurement and survey, formulate a decontamination plan based on the results thereof, and conduct decontamination in line with the plan.
- The national government takes financial measures and technical measures to assist these municipalities.

\* Iwate Prefecture, Miyagi Prefecture, Fukushima Prefecture, Ibaraki Prefecture, Tochigi Prefecture, Gunma Prefecture, Saitama Prefecture and Chiba Prefecture

Prepared based on the website, "Environmental Remediation," of the Ministry of the Environment"

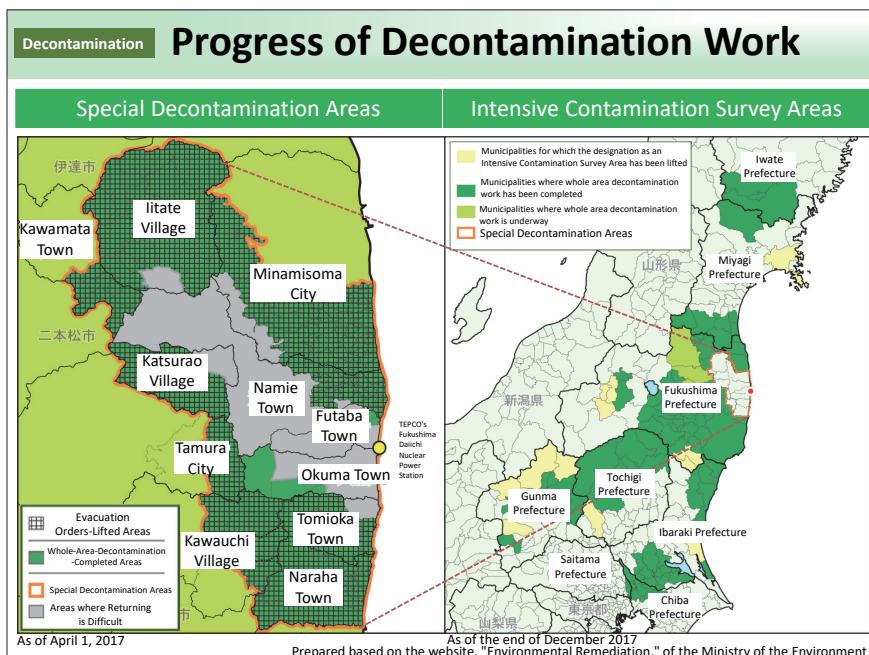
After the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS, the Diet enacted the Act on Special Measures Concerning the Handling of Environment Pollution by Radioactive Materials in August 2011.

Special Decontamination Areas and Intensive Contamination Survey Areas were designated as areas where decontamination is to be conducted under this Act on Special Measures. The decontamination has been conducted in these areas in line with the Act and the Basic Policy based thereon. Areas especially necessary from the perspective of protecting human health were prioritized. Soil, etc. removed through decontamination work is collected, transported to Temporary Storage Sites, and disposed of safely.

Special Decontamination Areas are areas where the national government directly conducts decontamination work. 11 municipalities in Fukushima Prefecture which were once designated as a Restricted Area or a Deliberate Evacuation Area are designated. In these areas, a decontamination plan is to be formulated for each area, while taking into account respective municipalities' needs, and decontamination is conducted in line with the plan.

Intensive Contamination Survey Areas are areas where municipalities take the initiative in decontamination work. 92 municipalities in 8 prefectures are designated (as of the end of December 2017) from among municipalities including areas where measured ambient dose rates were 0.23  $\mu\text{Sv/h}$  or higher. In these areas, each municipality carries out monitoring, formulates a decontamination plan based on the results thereof, and conducts decontamination in line with the plan. The national government takes financial measures and technical measures to assist these municipalities.

Included in this reference material on March 31, 2013  
Updated on February 28, 2018



In the 11 municipalities in Fukushima Prefecture designated as Special Decontamination Areas, the Ministry of the Environment conducted decontamination and whole area decontamination work was completed in all designated municipalities by the end of March 2017 (excluding Areas where Returning is Difficult). Decontamination was completed for approx. 22,000 housing sites, approx. 8,400 ha of farmland, approx. 5,800 ha of forests and approx. 1,400 ha of roads.

In municipalities where whole area decontamination work was completed, radiation monitoring after decontamination has been carried out for such purposes as confirming the maintenance of the effects of decontamination. As a result of such measures, evacuation orders were all lifted by April 1, 2017, for Habitation Restricted Areas and Preparation Areas for Lift of Evacuation Order except for Futaba and Okuma.

Each municipality in Intensive Contamination Survey Areas formulated a decontamination plan in light of the circumstances of the respective areas, priorities and feasibility, and has conducted decontamination work based thereon. As of the end of December 2017, decontamination work was underway in three cities in Fukushima Prefecture.

Additionally, it was confirmed that radiation doses decreased to below 0.23  $\mu\text{Sv/h}$  in 12 municipalities by the end of March 2017, and the designation as Intensive Contamination Survey Areas was removed for these 12 municipalities. Accordingly, the number of municipalities designated as Intensive Contamination Survey Areas decreased from 104 to 92.

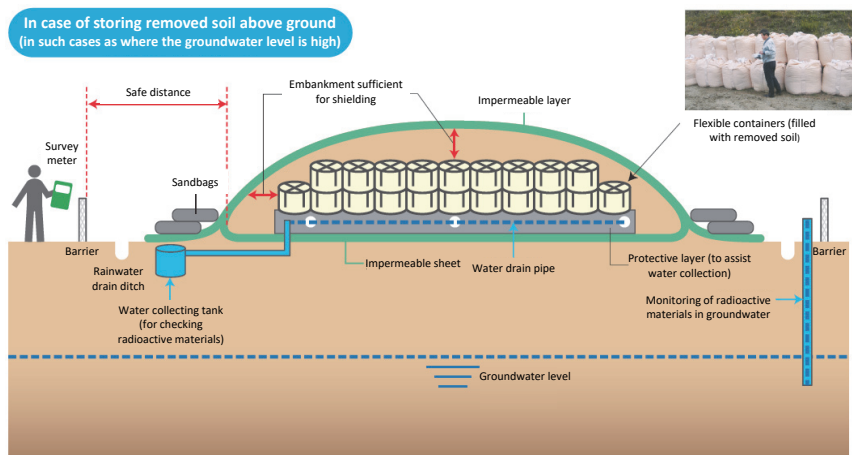
Included in this reference material on February 28, 2018

## Storage of Removed Soil, etc.

## Storage in Temporary Storage Sites (When Storing Removed Soil above Ground)

**Soil removed through decontamination work is stored safely on site or at Temporary Storage Sites for a certain period of time.**

**In case of storing removed soil above ground  
(in such cases as where the groundwater level is high)**



Prepared based on the website, "Environmental Remediation," of the Ministry of the Environment

Soil, etc. removed through decontamination work is stored and managed temporarily on site or at Temporary Storage Sites.

Specifically, removed soil is put in a container (flexible container, etc.) and placed on an impermeable layer (impermeable sheet, etc.), and is shielded sufficiently by such methods as placing sandbags filled with uncontaminated soil around the site to reduce ambient dose rates at the boundary to the same level as that in the surrounding areas.

Additionally, the site is covered with an impermeable sheet, etc., thereby preventing scattering and leakage of removed soil and further preventing infiltration of rainwater and resulting contamination of groundwater, etc.

Radiation doses at the site and radioactivity concentrations in groundwater are measured regularly.

Furthermore, from the perspective of keeping the site away from the public (securing distance), public access to the site is prohibited, and shortening of working hours and other measures are also considered from the perspective of reducing workers' exposure to radiation (p.168 of Vol. 1, "Three Principles of Reduction of External Exposure").

Included in this reference material on March 31, 2013

Updated on February 28, 2018



## Others

## Comprehensive Efforts toward Regeneration of Forests and Forestry in Fukushima

○ In order to ensure safe and secure lives of the residents and regenerate forests and forestry in Fukushima, relevant ministries and agencies carry out the following measures comprehensively in collaboration with the prefecture and municipalities, while obtaining the understanding of the people in Fukushima.

### I. Efforts toward regeneration of forests and forestry

#### 1. Efforts for ensuring safe and secure living environment

- Steadily continue decontamination work for forests near people's houses, etc.
- For residential areas surrounded by forests on three sides, taking measures as necessary, such as decontaminating forests 20m or further from the border or installing barriers to prevent soil runoff

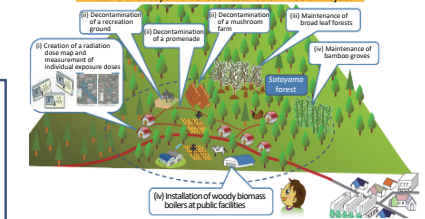
#### 3. Efforts for regenerating forestry in mountainous areas, etc.

- Promote a project to conduct tree thinning or other forest maintenance work together with measures concerning radioactive materials, and a demonstration project aiming for regeneration of forestry
- Newly prepare a guidebook on radiation safety that is easy to understand for workers

#### 2. Efforts for restoring *Satoyama* forests close to residential houses

- Based on needs of local people, properly conduct decontamination work at places in the forest where residents enter or take rest; Make efforts for regenerating forestry in broad leaf forests and bamboo groves, etc.
- Select model districts in and around Areas under Evacuation Orders (including areas where evacuation orders have been lifted), comprehensively promote efforts for restoring *Satoyama* forests in those model districts, and reflect the outcomes of such efforts in carrying out further measures in an appropriate manner

Picture of *Satoyama* Forest Restoration Model Project



### II. Future-oriented efforts for research and studies

- Continuously engage in research and studies for monitoring radiation doses in the forest, understanding behavior of radioactive materials and reducing radiation doses; Continue efforts for regeneration of forests and forestry into the future while utilizing the outcomes of such research and studies in formulating further measure

### III. Information provision and communication

- Meticulously provide the latest information regarding knowledge on radioactive materials in forests and the national government's efforts toward regeneration of forests and forestry, using such media as relevant ministries' websites and PR magazines
- Continue efforts for ensuring safe and secure lives of the people in Fukushima through maintaining good communication, including dispatching experts

Prepared by the Ministry of the Environment

In addition to decontamination work, comprehensive efforts for regenerating forestry and ensuring safe and secure lives of the residents are indispensable for the regeneration of forests and forestry in Fukushima Prefecture. Based on the guideline, "Comprehensive Efforts toward Regeneration of Forests and Forestry in Fukushima," relevant ministries and agencies have been carrying out measures comprehensively in collaboration with the prefecture and municipalities, while obtaining the understanding of the people in Fukushima.

According to the knowledge obtained at the Environment Restoration Panel established in the Ministry of the Environment, it is found that removal of sedimentary organic materials at locations 20m or further from the edge of the forest has little effect in reducing ambient dose rates at the forest edge. Removal of sedimentary organic materials broadly in forests may even make things worse, in ways such as increasing bad effects on trees due to causing erosion of dirt, etc. containing radioactive cesium or impoverishing the soil. Accordingly, under the basic policy to prioritize areas especially necessary from the perspective of protecting human health, decontamination of forests has been conducted within approx. 20m from the edges of the forests adjacent to houses or farmland, etc.

Additionally, it was determined to implement a model project to comprehensively facilitate efforts for restoring *Satoyama* forests including decontamination work. In September and December 2016, the Reconstruction Agency, the Ministry of Agriculture, Forestry and Fisheries, and the Ministry of the Environment jointly selected a total of 10 municipalities as model districts (Kawamata Town, Hirono Town, Kawauchi Village, Katsurao Village, Soma City, Nihonmatsu City, Date City, Tomioka Town, Namie Town and Iitate Village).

Included in this reference material on March 31, 2017

Updated on February 28, 2018

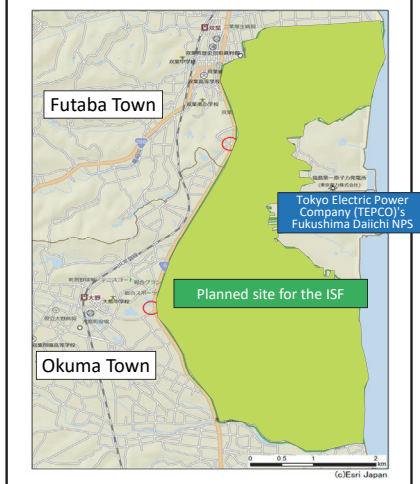
## Outline of the Interim Storage Facility

- In Fukushima Prefecture, large quantities of contaminated soil and waste have been generated from decontamination works.
- \* Estimated to be approx. 16 million to 22 million m<sup>3</sup> (equivalent to approx. 13 to 18 times the volume of the Tokyo Dome)
- Currently, it is difficult to clarify methods of final disposal of the soil and waste.
- **It is necessary to establish an Interim Storage Facility (ISF) in order to manage and store the soil and waste safely and intensively until final disposal.**

(Site Area: approx. 16 km<sup>2</sup>)

- Removed soil and waste generated from decontamination works in Fukushima Prefecture and incineration ash with radioactivity concentrations exceeding 100,000 Bq/kg are stored.
- The national government has legally specified its intention to take measures necessary for completing final disposal outside Fukushima Prefecture within 30 years after the commencement of interim storage (the Amended JESCO (Japan Environmental Storage & Safety Corporation) Act was promulgated in November 2014).

## &lt; Planned site for the Interim Storage Facility &gt;



Prepared by the Ministry of the Environment

In Fukushima Prefecture, large quantities of contaminated soil and waste have been generated from decontamination works. The volume even after incineration of combustibles is estimated to be approx. 16 million to 22 million m<sup>3</sup>, which is equivalent to approx. 13 to 18 times the volume of the Tokyo Dome.

Currently, it is difficult to clarify methods of final disposal of the soil and waste, and it is indispensable to establish an ISF as a facility to manage and store the soil and waste safely and intensively until final disposal.

At the ISF, the following are to be stored:

- (i) Removed soil and waste (e.g. fallen leaves and branches, etc.) generated from decontamination works which is currently stored in Temporary Storage Sites;
- (ii) Incineration ash with radioactivity concentrations exceeding 100,000 Bq/kg.

Consent to accept the construction of the ISF was obtained from Fukushima Prefecture in September 2014 and from Okuma Town and Futaba Town in January 2015. The total area of the planned site is approx. 16 km<sup>2</sup>, almost the same area as Shibuya Ward in Tokyo.

Included in this reference material on January 18, 2016

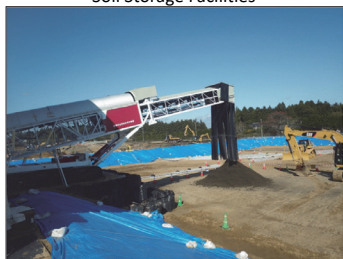
Updated on February 28, 2018

# Construction of Interim Storage Facility

Reception/Separation Facilities

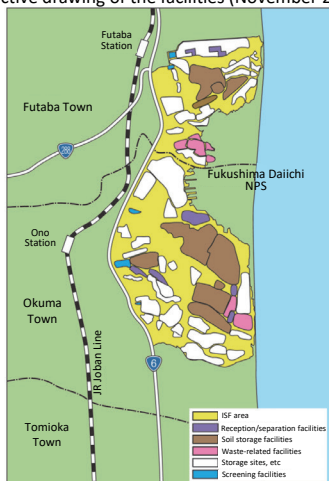


Soil Storage Facilities



Source: Reference material for the 9th meeting of the Committee on Environmental Safety of the ISF (Ministry of the Environment)

&lt;Perspective drawing of the facilities (November 2017)&gt;



\* The figure above shows the envisaged area for each facility as of November 2017, within which facility construction is to be conducted concentrated in a certain location in light of the landform and progress of land acquisition. The plan can be changed in accordance with the progress of land acquisition and facility construction.

Prepared by the Ministry of the Environment

The site necessary for the construction of the ISF is estimated to be approx. 1,600 ha and the number of relevant registered land owners is 2,360. By the end of December 2017, the contracts have been steadily increasing to approx. 801 ha (approx. 50.1% of the envisaged construction site) with 1,331 land owners (approx. 56.4% of the total). The national government considers it most important to obtain understanding on the construction of the ISF, not to mention building a relationship of trust with land owners, and is committed to continuing efforts while providing sufficient explanations to land owners.

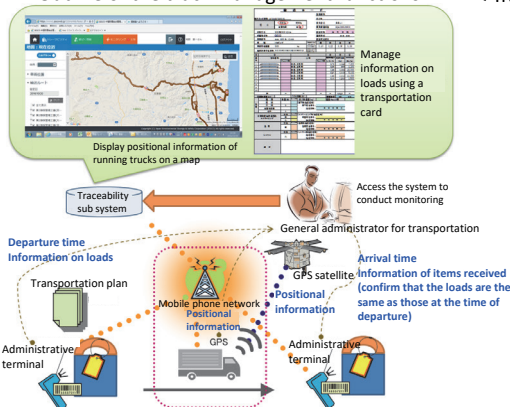
Construction of the Reception/Separation Facilities and Soil Storage Facilities started in November 2016. The Reception/Separation Facilities receive the removed soil and waste which is transported from the Temporary Storage Sites in Fukushima Prefecture to the ISF. The soil and waste is unloaded from trucks, taken out from container bags and separated into combustibles and incombustibles. The Soil Storage Facilities store the soil and waste treated at the Reception/Separation Facilities safely in accordance with the radioactivity concentrations and other properties. Reception and separation of the removed soil and waste started in June 2017 and storage of the treated soil and waste started in October 2017. Construction of the facilities will be continued in order to further promote treatment and storage of the removed soil and waste.

Included in this reference material on February 28, 2018

- An accumulative total of approx. 640,000 m<sup>3</sup> of the removed soil and waste had been transported to the ISF by the end of January 2018.
- Approx. 1.8 million m<sup>3</sup> of the removed soil and waste is planned to be transported in FY2018.
- Safe and secure transportation will be sequentially conducted through managing the whole numbers of transport objects and operation of trucks used for transport, and conducting environmental monitoring, etc.

## &lt; Outline of the truck management functions &gt;

## &lt; Transportation of the soil and waste &gt;



Prepared by the Ministry of the Environment

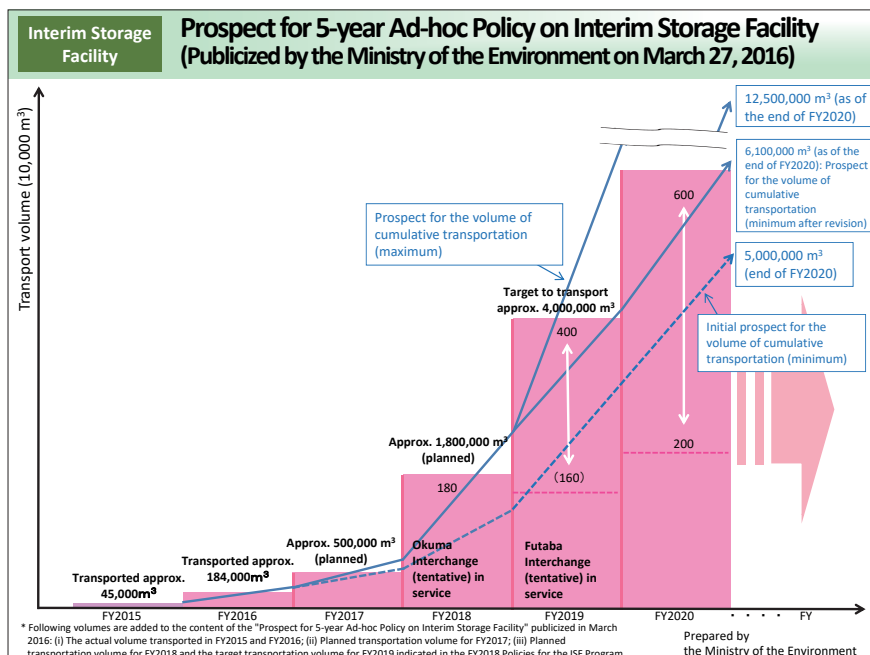
By the end of January 2018, an accumulative total of approx. 640,000 m<sup>3</sup> of the removed soil and waste had been transported to the ISF. Approx. 1.8 million m<sup>3</sup> of the removed soil and waste is planned to be transported in FY2018.

The operation of trucks used for transportation is managed on a real-time basis using GPS as follows.

(i) All loads are linked to respective trucks by the unit of container bags at the time of departure from loading sites and trucks are managed together with their loads.

(ii) Positional information of running trucks is ascertained using GPS devices loaded thereon and is recorded in the system. Recorded positional information is displayed on a map and the operation of trucks is monitored. Trucks are continuously monitored even after unloading the items at the ISF and returning back to loading sites with an empty load.

Included in this reference material on February 28, 2018



The Ministry of the Environment publicized the "Prospect for 5-year Ad-hoc Policy on Interim Storage Facility" on March 27, 2016.

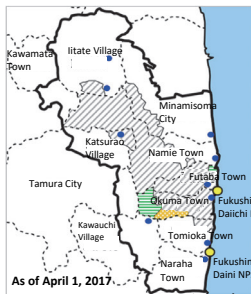
The amount equivalent to the total amount of the soil and waste currently being stored on sites, such as schools or individuals' houses, will be transported to the ISF. Utmost efforts should be made to acquire the land for construction of the related facilities and it is targeted to transport an amount of the removed soil and waste equivalent to that currently being placed along the major roads to the ISF. By FY2020, it is forecast that transportation of approx. 5 million to 12.5 million m<sup>3</sup> of removed soil and waste will be achieved. From which Temporary Storage Site to start transport is up to each municipality.

The above figure also includes the actual volume transported in FY2015 and FY2016 and planned transportation volume for FY2017, as well as planned transportation volume for FY2018 and the target transportation volume for FY2019 indicated in the FY2018 Policies for the ISF Program. This prospect can be revised as needed in light of the progress of the ISF Program.

Included in this reference material on March 31, 2017

Updated on February 28, 2018

## Progress of Disposal of Disaster Waste Directly Governed by the National Government in Designated Areas in Fukushima Prefecture

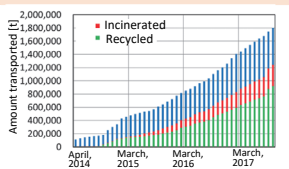


Temporary Incineration Facility in Okuma Town (December 2017)

Disaster waste has been disposed of based on the Treatment Plan on Waste within the Management Areas (partial revision on December 26, 2013).

[Amount of Waste within the Management Areas having been transported to Temporary Storage Sites]

As of the end of November 2017, a total of approx. 1.80 million tons of waste had been transported to Temporary Storage Sites (of which, approx. 320,000 tons were incinerated and approx. 920,000 tons were recycled).



[Removal of tsunami rubble]

OTsunami rubble in former Restricted Areas was all transported to Temporary Storage Sites in March 2016, except for such rubble left in Areas where Returning is Difficult.

[Installation of Temporary Incineration Facilities]

Now treating disaster waste, etc.	Tomioka Town, Minamisoma City, Katsurao Village, Namie Town, Iitate Village (Warabidaira district), Naraha Town and Okuma Town
Preparing for placing orders	Futaba Town
Disposal of disaster waste completed	Kawauchi Village and Iitate Village (Komiya district)

\* Tamura City and Kawamata Town use existing waste disposal facilities for disposing of disaster waste.



Temporary Incineration Facility in Naraha Town (Oct. 2016)

Prepared by the Ministry of the Environment

Waste within the Management Areas in Fukushima Prefecture has been disposed of based on the Plan on Waste within the Management Areas, which was revised in December 2013.

Such waste, which includes tsunami rubble, debris of damaged houses, and waste from houses after cleaning-up, has been transported sequentially to Temporary Storage Sites. As of the end of November 2017, a total of approx. 1.8 million tons had already been transported. Transported waste is recycled as much as possible.

It was decided to incinerate inflammable waste to reduce volume at provisional incineration facilities to be constructed at ten locations in nine municipalities. As of January 2018, seven such facilities were in operation and waste is being steadily disposed of and treated.

Included in this reference material on February 28, 2018

## Waste

# Ensuring Safety for Temporary Storage of Designated Waste

## Temporary storage work (in the case of agricultural by-products)



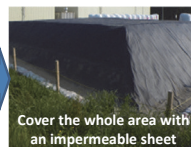
Elevate a certain parcel of land by adding soil



Put waste in tough bags and surround those bags with sandbags



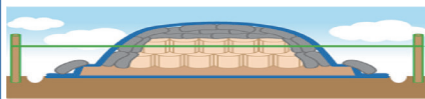
Cover them up with soil to shield radiation



Cover the whole area with an impermeable sheet

### Structure of a Temporary Storage Site (in the case of agricultural by-products)

- Take measures to prevent scattering and runoff of waste
- Take required measures against radiation (isolation or shielding using sandbags, etc.)
- Take measures to prevent infiltration of rainwater using impermeable sheet, etc.



### Checking of storage status

The status of storage at Temporary Storage Sites is to be checked to ensure that designated waste is properly stored in compliance with the standards, etc. specified in the Act on Special Measures.



Staff of the Regional Environmental Office checking the storage status

Prepared based on the website, "Information on Disposal of Radioactive Waste," of the Ministry of the Environment

Designated waste includes ash left after incinerating waste contaminated with radioactive materials, sludge generated through sewage treatment, soil that remains at purification plants to supply tap water (p.31 of Vol. 2, "Waterworks System"), agricultural by-products such as rice straw and pasture grass, etc.

As of September 30, 2017, there was a total of over 200,000 tons of designated waste in 11 prefectures including Tokyo Metropolis. Such waste is temporarily being stored at incineration facilities, purification plants, sewage treatment facilities, farmland, etc., where it was generated, until the national government establishes a proper disposal system.

The waste is to be covered with impermeable sheets, etc. to prevent infiltration of rainwater and measures to prevent scattering and runoff of the waste are supposed to be taken voluntarily in line with the guidelines and the Act on Special Measures Concerning the Handling of Environment Pollution by Radioactive Materials. Officials of the Ministry of the Environment visit various locations and check the status of temporary storage periodically to ensure safe and proper storage of designated waste.

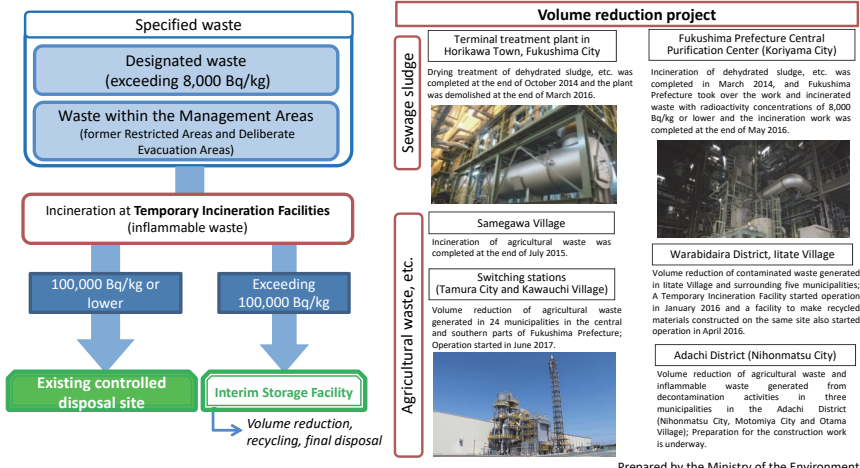
Included in this reference material on January 18, 2016

Updated on February 28, 2018



## Procedures for Disposal of Designated Waste in Fukushima Prefecture

The Ministry of the Environment has been carrying out a program to reduce volume and stabilize properties of designated waste through incineration and drying, etc. With regard to designated waste generated in Fukushima Prefecture, waste with radioactivity concentrations exceeding 8,000 Bq/kg but 100,000 Bq/kg or lower is to be transported to the existing controlled disposal site, while waste with radioactivity concentrations exceeding 100,000 Bq/kg is to be transported to the Interim Storage Facility.



With regard to disposal of designated waste, the national government is committed to securing long-term management facilities required for the prefectures where a large amount of designated waste has been generated and storage facilities are in urgent need, while considering the utilization of existing waste disposal facilities.

In Fukushima Prefecture, waste with radioactivity concentrations exceeding 8,000 Bq/kg but 100,000 Bq/kg or lower is to be transported to the existing controlled disposal site, while waste with radioactivity concentrations exceeding 100,000 Bq/kg is to be transported to the Interim Storage Facility.

Additionally, designated waste is incinerated, dried or otherwise handled to reduce volume and stabilize their properties in Fukushima Prefecture.

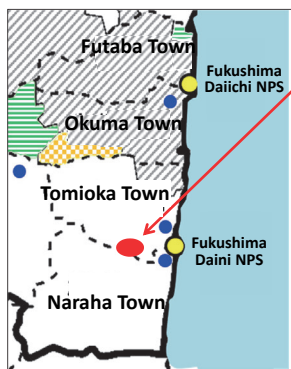
Included in this reference material on January 18, 2016

Updated on February 28, 2018



## Landfill Disposal Plan of Specified Waste Utilizing the Controlled Disposal Site

In order for reconstruction of eight municipalities in Futaba County and ultimately the entirety of Fukushima Prefecture, the issue of waste contaminated with radioactive materials needs to be solved as early as possible. It is planned to safely and promptly bury waste with radioactivity concentrations not exceeding 100,000 Bq/kg at the existing controlled disposal site, former Fukushima Ecotec Clean Center. Transport of specified waste was commenced in November 2017.



● Temporary Incineration Facilities (including planned facilities and those already demolished, etc.)  
 ■ Contaminated Waste Management Areas  
 ■ Preparation Areas for Lift of Evacuation Order  
 ■ Habitation Restricted Areas  
 ■ Areas where Returning is Difficult

Prepared by the Ministry of the Environment

### Specified Waste Landfill Disposal Facility (Former Fukushima Ecotec Clean Center)

[Outline of the facility]

- Location: in Tomioka Town (transport via Naraha Town)
- Area: approx. 9.4 ha
- Capacity: approx. 960,000 m<sup>3</sup> (Possible landfill capacity: approx. 650,000 m<sup>3</sup>)

### Outline of the landfill disposal program

#### ○ Waste to be buried

- Household refuse of returned residents in eight municipalities in Futaba County < approx. 27,000 m<sup>3</sup> >
- Waste within the Management Areas < approx. 445,000 m<sup>3</sup> >
- Designated waste in Fukushima Prefecture < approx. 182,000 m<sup>3</sup> >

#### ○ Period

- Household refuse from eight municipalities in Futaba County: for approx. 10 years
- Waste within the Management Areas and designated waste: for approx. 6 years

#### ○ Landfill disposal, radiation monitoring, etc.

- Multiple safety measures should be taken to prevent leakage of radioactive materials such as curbing elution of radioactive cesium or infiltration of rainwater.
- The status of seepage control and leachate treatment facility, etc. is to be periodically checked and ambient dose rates and radioactivity concentrations of groundwater, etc. should be monitored.

#### ○ Responsibility of the Ministry of the Environment and its management system

- Based on the Act on Special Measures, the Ministry of the Environment will serve as the responsible entity and initially nationalize the disposal site and responsibly conduct landfill disposal of specified waste.
- The Ministry of the Environment constantly stations a supervisor at a newly established local office, thereby ensuring a system to properly manage landfill disposal and related facilities.

Waste with radioactivity concentrations not exceeding 100,000 Bq/kg generated in Fukushima Prefecture is to be buried promptly at the existing controlled disposal site.

In order to implement this program, the national government first asked local communities for consent to accept the construction of an Interim Storage Facility in December 2013, and then provided explanations to the authorities, assemblies and residents of Tomioka Town and Naraha Town.

In December 2015, consent was obtained from Fukushima Prefecture, Tomioka Town and Naraha Town for the implementation of this program. The national government nationalized the existing controlled disposal site in April 2016 and concluded a safety agreement with Fukushima Prefecture and the two municipalities in June 2016. Preparatory work was conducted thereafter and the transport of waste to the facility was commenced in November 2017.

In order to steadily facilitate disposal of waste contaminated with radioactive materials, utmost efforts will be continued to properly carry out this program with safety as the top priority and to build a stronger relationship of trust with local residents.

Included in this reference material on January 18, 2016

Updated on February 28, 2018

## Status of the Five Prefectures concerning Designated Waste

< Miyagi Prefecture >	< Tochigi Prefecture >	< Chiba Prefecture >	< Ibaraki Prefecture >	< Gunma Prefecture >
<ul style="list-style-type: none"> <li>Municipal mayors' conference (14 meetings) [Oct. 2012 to July 2017]</li> </ul>	<ul style="list-style-type: none"> <li>Municipal mayors' conference (8 meetings) [April 2013 to Oct. 2016]</li> </ul>	<ul style="list-style-type: none"> <li>Municipal mayors' conference (4 meetings) [April 2013 to April 2014]</li> </ul>	<ul style="list-style-type: none"> <li>Municipal mayors' conference (4 meetings) [April 2013 to Jan. 2015]</li> </ul>	<ul style="list-style-type: none"> <li>Municipal mayors' conference (3 meetings) [April 2013 to Dec. 2016]</li> </ul>
<p><b>2014</b> Jan.: 3 candidate sites for detailed survey were presented (Fukuyamadake, Kurihara City; Shinohara, Taiwa-cho; Tashirodake, Kami Town). Aug.: The prefectural governor announced the acceptance of a detailed survey as a consensus of all municipal mayors. Aug.: A detailed survey was commenced. An on-site survey was not possible due to protests by local residents.</p> <p><b>2016</b> March: Results of the remeasurement for designated waste were released. Nov.: Results of the remeasurement for other types of designated waste were released.</p> <p><b>2017</b> June: The prefecture presented draft disposal policies such as to require each area to independently incinerate contaminated waste generated therein, and each municipality would carry out further municipality-level discussions on the draft. July: The draft disposal policies were agreed as they are.</p>	<p><b>2014</b> July: One candidate site for detailed survey was presented (Terashimairi, Shiyoa Town). <b>2016</b> Oct.: Results of the remeasurement for designated waste were released and future directions were presented. <b>2017</b> July: Meeting of mayors of municipalities concerning measures to ease burdens of farm households storing waste by themselves → Draft of Policy for measures to ease burdens of farm households storing waste by themselves were presented.</p>	<p><b>2015</b> April: 1 candidate site for detailed survey was presented. (Part of the premises of Tokyo Electric Power Company (TEPCO)'s Chiba Thermal Power Station (Chuo Ward, Chiba City)) <b>2016</b> July: Designation was removed for designated waste whose radioactivity concentrations had become lower than 8,000 Bq/kg.</p>	<p><b>2015</b> April: Meeting of mayors of municipalities where waste is temporarily stored <b>2016</b> Feb.: 2nd meeting of mayors of municipalities where waste is temporarily stored → The policy to continue on-site storage and promote staged disposal was determined. <b>2017</b> March: Results of the remeasurement for designated waste, etc. in the prefecture were released.</p>	<p><b>2016</b> Dec.: The policy to continue on-site storage and promote staged disposal was determined.</p>

### (Reference) Expert meeting of the Ministry of the Environment

The Ministry of the Environment had meetings (nine times) to discuss the safety of long-term management facilities and process of selecting candidate sites from a scientific and technological point of view, in tandem with the municipal mayors' conferences held by these prefectures. [March 2013 to March 2016]

Prepared based on reference material for the Third Panel on Safety Measures against Radioactive Materials (Nov. 2015), Ministry of the Environment

Prefectures other than Fukushima Prefecture which are in urgent need to secure Temporary Storage Sites for designated waste (Miyagi Prefecture, Tochigi Prefecture, Chiba Prefecture, Ibaraki Prefecture and Gunma Prefecture) are taking measures in accordance with the circumstances of respective prefectures. They ascertain the current status through the measurement of radioactivity concentrations, based on discussions at municipal mayors' conferences.

Regarding candidate sites for detailed surveys, Miyagi, Tochigi and Chiba Prefectures followed selection methods determined through discussions at expert meetings and municipal mayors' conferences, and presented selected candidate sites in January 2014, July 2014 and April 2015, respectively. However, detailed surveys have not been conducted smoothly or not been conducted due to protests by local residents.

In the meantime, Miyagi Prefecture determined its policy in July 2017 to the first dispose of contaminated waste with radioactivity concentrations not exceeding 8,000 Bq/kg, excluding designated waste, at respective areas, and is now making adjustments for commencing test incineration.

In July 2017, the Ministry of the Environment presented a provisional policy for volume reduction and centralized collection of designated waste, targeting Tochigi Prefecture and municipalities storing waste, with the aim of easing burdens of farm households that have been storing waste by themselves, while maintaining the basic policy to ultimately develop long-term management facilities. Accordingly, Tochigi Prefecture is now making adjustments for commencing disposal based on the presented provisional policy.

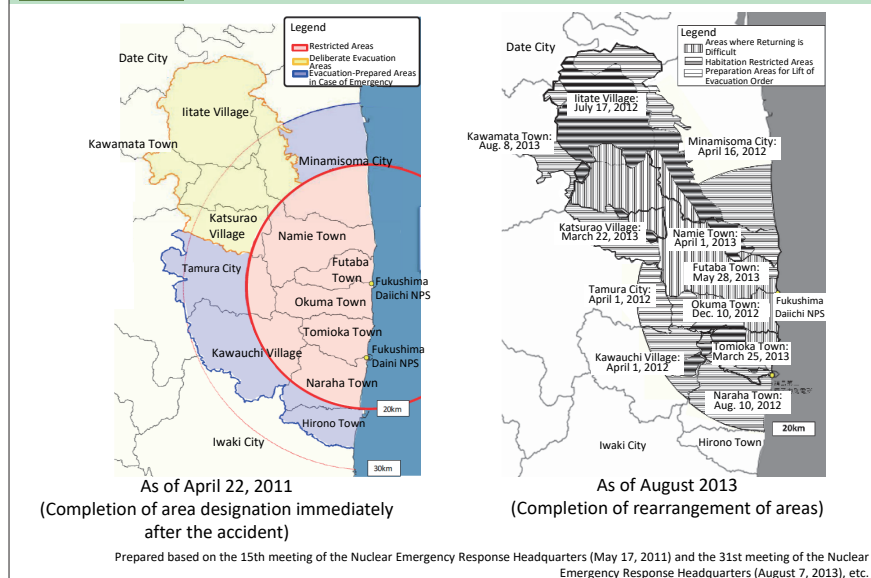
Chiba Prefecture is also making efforts to obtain understanding of local residents for the implementation of a detailed survey concerning long-term management facilities.

Ibaraki and Gunma Prefectures determined the policies to continue on-site storage and promote staged disposal respectively in February 2016 and December 2016. Based on the determined policies, both prefectures will repair or reinforce storage sites as necessary and will dispose of designated waste whose radioactivity concentrations have reduced to 8,000 Bq/kg or lower at existing disposal facilities in a staged manner.

Included in this reference material on March 31, 2016

Updated on February 28, 2018

## Designation of Areas under Evacuation Orders



Based on Article 15, paragraph (2) of the Act on Special Measures Concerning Nuclear Emergency Preparedness, a Declaration of a Nuclear Emergency Situation was issued at 19:03 on March 11, 2011. The Chief Cabinet Secretary announced the issuance of the declaration during the press conference at around 19:45 on the day. At 18:25 on the following day, evacuation orders were issued for the 20-km zone of Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS.

As there were areas within the 20-km zone where annual cumulative doses would be highly likely to exceed 20 mSv after the accident, such areas were designated as Deliberate Evacuation Areas, taking into account the standard limits for radiological protection in emergency exposure situations. Considering future risks due to the accident, areas within 20 km from the NPS were designated as Restricted Areas and access was prohibited in principle, while areas within 20 km to 30 km were designated as Evacuation-Prepared Areas in Case of Emergency.

On June 5 onward, spots where decontamination work would not be easy and annual cumulative doses would be highly likely to exceed 20 mSv were designated as specific spots recommended for evacuation, based on the results of the environmental monitoring by the national government and Fukushima Prefecture.

On December 16, the reactors reached a state of cold shutdown and it was confirmed that the release of radioactive materials was under control. Accordingly, on December 26, the designation of Restricted Areas was removed and it was proposed to review Areas under Evacuation Orders and to newly designate Areas where Returning is Difficult, Habitation Restricted Areas and Preparation Areas for Lift of Evacuation Order. Upon reviewing Areas under Evacuation Orders, four problems common to all subjected areas were cited as problems to be addressed: (i) need to ensure safety and security of residents; (ii) need for decontamination and due consideration to children's radiation exposure; (iii) reconstruction of infrastructure and job creation; and (iv) compensation.

As indispensable requirements for lifting evaluation orders, the following were set: (i) it is certain that annual cumulative doses will become 20 mSv or lower after removal of the designation; (ii) infrastructure and living-related services necessary for daily lives have been almost restored and decontamination work has progressed sufficiently centered on children's living environments; and (iii) consultations have been held sufficiently among relevant local governments and residents.

Included in this reference material on February 28, 2018

April 22, 2011, onward Area designation immediately after accident	April 2012, onward After confirming cold shutdown of the reactors
<b>Restricted Areas</b> Areas within 20 km in radius from the Nuclear Power Station (NPS); The relevant areas were designated as Areas under Evacuation Orders on March 12, 2011.	<b>Preparation Areas for Lift of Evacuation Order</b> Areas where it is confirmed that annual cumulative doses will surely become 20 mSv or lower <sup>(*)</sup>
<b>Deliberate Evacuation Areas</b> Areas 20 km or farther from the NPS where cumulative doses would be highly likely to exceed 20 mSv within one year after the accident	<b>Habitation Restricted Areas</b> Areas where annual cumulative doses would be highly likely to exceed 20 mSv <sup>(*)</sup>
<b>Evacuation-Prepared Areas in Case of Emergency</b> Areas within 20 km to 30 km in radius from the NPS other than Deliberate Evacuation Areas; The relevant areas were designated as In-house Evacuation Areas on March 12, 2011.	<b>Areas where Returning is Difficult</b> Areas where annual cumulative doses exceed 50 mSv <sup>(*)</sup> at present and would be highly likely to remain above 20 mSv <sup>(*)</sup> even after 6 years from the accident

(\*) Based on the dose data obtained through the 4th airborne monitoring survey after correction as of March 31, 2012

#### Areas under Evacuation Orders:

Areas for which evacuation orders were issued based on Article 15, paragraph (3) of the Act on Special Measures Concerning Nuclear Emergency Preparedness; Areas under Evacuation Orders and the 20-km zone of the Nuclear Power Station were rearranged and were newly designated as Preparation Areas for Lift of Evacuation Order, Habitation Restricted Areas or Areas where Returning is Difficult.

#### Restricted Areas:

Areas where access is restricted pursuant to the provisions of Article 63, paragraph (1) of the Disaster Countermeasures Basic Act as applied pursuant to Article 28, paragraph (2) of the Act on Special Measures Concerning Nuclear Emergency Preparedness, following the deemed replacement of terms

Prepared based on the "Basic Idea on Review of the Restricted Areas and Areas under Evacuation Orders in Response to the Completion of Step 2 and Matters to be Discussed" (December 26, 2011; Nuclear Emergency Response Headquarters)

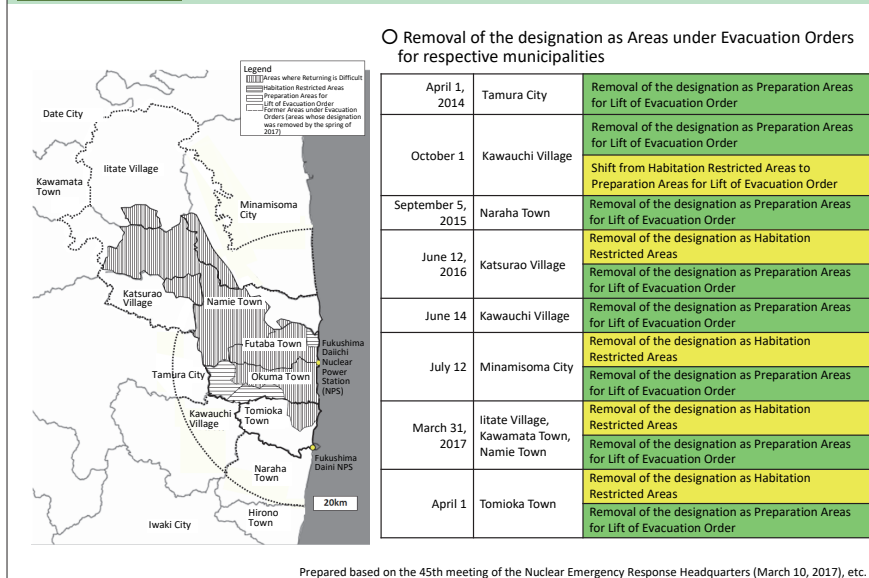
Immediately after the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS on March 11, 2011, the Nuclear Emergency Response Headquarters issued evacuation orders in order to avoid risks to residents' lives and designated the areas within 20 km from the NPS as Areas under Evacuation Orders on March 12.

On April 22, for fear of any risks that residents might be exposed to a large amount of radiation at one time as a result of worsening of the situation, the Headquarters designated the relevant areas as Restricted Areas to prohibit access in principle, and also designated areas 20 km or farther from the NPS where cumulative doses would be highly likely to exceed 20 mSv within one year after the accident as Deliberate Evacuation Areas.

On December 16, the reactors reached a state of cold shutdown and the Nuclear Emergency Response Headquarters confirmed that the chaotic situation after the accident ended. Accordingly, on December 26, the basic idea on review of Restricted Areas and Areas under Evacuation Orders was presented. The Headquarters made preparations for the review while closely consulting with the prefecture, municipalities and residents and making adjustments, and at the same time endeavored to address problems common to all subjected areas.

On March 30, 2012, the Headquarters reviewed Restricted Areas and Areas under Evacuation Orders in accordance with radiation doses and problems unique to respective areas. By August 2013, the designation of Restricted Areas and Specific Spots Recommended for Evacuation was completely removed and Areas under Evacuation Orders were newly designated as Areas where Returning is Difficult, where physical protection measures such as installation of barricades were taken, Habitation Restricted Areas, where evacuation is required in principle, or Preparation Areas for Lift of Evacuation Order, where situations are considered to have reached existing exposure situations and support measures for reconstruction and recovery are to be promptly taken.

Included in this reference material on February 28, 2018



At the joint meeting of the Reconstruction Promotion Committee and the Nuclear Emergency Response Headquarters held on March 7, 2013, it was pointed out that "a certain view should be indicated within the year" regarding the lift of evacuation orders. Accordingly, procedures to be followed for lifting evacuation orders were presented based on the discussions over the Cabinet decision on December 20, 2013, "For Accelerating the Reconstruction of Fukushima from the Nuclear Disaster." In order to ease returning residents' anxiety over health effects of radiation, it was decided to take measures to reduce radiation exposure and eliminate health concerns (risk communication program). These measures include deployment of counselors, development of counselor support centers, ascertaining and management of personal doses, and radiation monitoring.

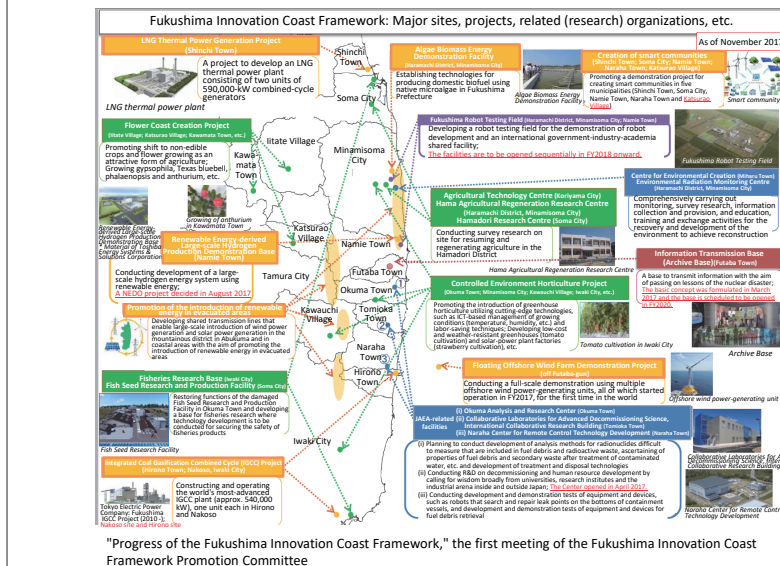
The revised "For Accelerating the Reconstruction of Fukushima from the Nuclear Disaster" (Cabinet decision on June 12, 2015) presents the policy to lift evacuation orders by March 2017 for all areas except for Areas where Returning is Difficult.

In the meantime, against a backdrop of decreasing radiation doses in Areas where Returning is Difficult and strong wishes of former residents eager to return home, the national government stepped forward to present its policy to develop the Specified Reconstruction and Revitalization Base in August 2016, based on requests of local residents and recommendations of the ruling parties. The development of the Specified Reconstruction and Revitalization Base, which aims to create new communities in tandem with the progress of reconstruction work, is to be carried out in response to the needs and requests of respective local governments, at the expense of the national government without seeking compensation from Tokyo Electric Power Company.

Prepared based on the following material:(i) Nuclear Emergency Response Headquarters' "For Accelerating the Reconstruction of Fukushima from the Nuclear Disaster" (December 20, 2013),(ii) revised version of Nuclear Emergency Response Headquarters' "For Accelerating the Reconstruction of Fukushima from the Nuclear Disaster" (June 12, 2015) (iii)Reconstruction Agency's "Draft of the Act Partially Amending the Act on Special Measures for Fukushima Reconstruction and Revitalization (Outline)" (February 2017)

Included in this reference material on February 28, 2018

## Fukushima Innovation Coast Framework



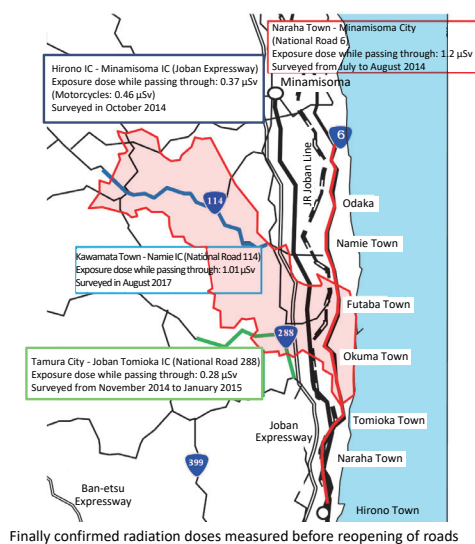
The Fukushima Innovation Coast Framework Workshop was first established in January 2014 with the aim of having people around the world witness the spectacular recovery of the Hamadori District at the time of the Tokyo Olympic and Paralympic Games in 2020. The Workshop compiled a report on the Fukushima Innovation Coast Framework in June 2014. The amended Act on Special Measures for Fukushima Reconstruction and Revitalization, which was promulgated in May 2017, provides for the promotion of the Framework and the relevant system was fundamentally strengthened with the creation of a ministerial-level council.

Fukushima Prefecture established a general incorporated foundation, "Fukushima Innovation Coast Framework Promotion Organization," in July 2017 with the aim of having it function as the central organization in promoting the Fukushima Innovation Coast Framework towards its realization.

Efforts are being made to materialize projects in the fields of decommissioning, robotics, energy and the agriculture, forestry and fisheries industry, etc. and to form industrial clusters, foster human resources, and increase the number of visitors, etc.

Included in this reference material on February 28, 2018

## Results of Radiation Dose Surveys along Major Roads in Areas where Returning is Difficult



### Joban Expressway

The entirety was restored with the reopening of the section between Namie IC and Joban Tomioka IC on March 1, 2015.

### JR Joban Line

The section between Tomioka Station and Namie Station is scheduled to be reopened at the end of FY2019.

### National roads and prefectural roads

Through operational change of the Special Transit Permission System, transit without carrying and presenting a pass came to be permitted for National Road 6 on September 15, 2014, for National Road 288 on February 28, 2015, and for National Road 114 on September 20, 2017.

### Exposure doses of drivers passing through, measured before reopening of roads

National Road 6 (special transit permission on September 15, 2014)

1.2  $\mu\text{Sv}$  (between Naraha Town and Minamisoma City)

\*Equivalent to one-167th of the exposure dose during a flight between Tokyo and New York (approx. 0.2 mSv)

Joban Expressway (reopened on March 1, 2015)

Four-wheeled vehicles: 0.37  $\mu\text{Sv}$ ; Motorcycles: 0.46  $\mu\text{Sv}$  (between Hirono IC and Minamisoma IC)

\*Equivalent to one-540th and one-430th, respectively, of the exposure dose during a flight between Tokyo and New York (approx. 0.2 mSv)

National Road 288 (special transit permission on March 1, 2015)

0.28  $\mu\text{Sv}$  (between Tama City and Joban Tomioka IC)

National Road 114 (special transit permission on September 20, 2017)

1.01  $\mu\text{Sv}$  (between Kawamata Town and Namie IC)

In Areas where Returning is Difficult, transit had been restricted except for temporary entry of residents and transit based on the Special Transit Permission System.

As National Road 6 is a key major road for reconstruction and recovery of Fukushima Prefecture, after completion of decontamination and road repair work, special transit without carrying and presenting a pass came to be permitted for National Road 6 and Prefectural Road 36 on September 15, 2014, as a result of consultations with the relevant municipalities.

In conjunction with the reopening of the section between Joban Tomioka IC and Namie IC of the Joban Expressway on March 1, 2015, special transit without carrying and presenting a pass was made possible for National Road 288 and Prefectural Road 35 on February 28, 2015, and for National Road 114 and Prefectural Roads 34 and 49 at 6:00 on September 20, 2017.

- Results of Radiation Dose Surveys along National Road 6 and Prefectural Road 36 in Areas where Returning is Difficult (September 12, 2014)

[http://www.meti.go.jp/earthquake/nuclear/pdf/kokudou6gou\\_press.pdf](http://www.meti.go.jp/earthquake/nuclear/pdf/kokudou6gou_press.pdf) (in Japanese)

- Results of Radiation Dose Surveys along National Road 288 and Prefectural Road 35 Including Areas where Returning is Difficult (February 25, 2015)

[http://www.meti.go.jp/earthquake/nuclear/pdf/0225\\_001a.pdf](http://www.meti.go.jp/earthquake/nuclear/pdf/0225_001a.pdf) (in Japanese)

- Results of Radiation Dose Surveys along Joban Expressway (between Joban Tomioka IC and Namie IC) and at Naraha PA (February 27, 2015)

[http://www.meti.go.jp/earthquake/nuclear/pdf/0227\\_001a.pdf](http://www.meti.go.jp/earthquake/nuclear/pdf/0227_001a.pdf) (in Japanese)

- Results of Radiation Dose Surveys in Areas where Returning is Difficult along National Roads 114, 399 and 459 and Prefectural Roads 49 and 34 (September 15, 2017)

[http://www.meti.go.jp/earthquake/nuclear/kinkyu/hinanshiji/2017/pdf/0915\\_04.pdf](http://www.meti.go.jp/earthquake/nuclear/kinkyu/hinanshiji/2017/pdf/0915_04.pdf) (in Japanese)

Included in this reference material on February 28, 2018





# Chapter 10

Health Management



## What is Fukushima Prefecture's Fukushima Health Management Survey?

Considering the effects of radiation due to the nuclear disaster, Fukushima Prefecture has been conducting the "Fukushima Health Management Survey" since June 2011 in order to monitor and improve the health of residents for the long term into the future.

**The Fukushima Health Management Survey consists of the following five components.**

- (i) Basic Survey (estimation of external doses)** (all residents)
- (ii) Detailed Surveys**
  - **Thyroid Examination** (residents aged around 18 or younger as of March 11, 2011)
  - **Comprehensive Health Checkup** (residents of municipalities under evacuation orders)
  - **Mental Health and Lifestyle Survey** (residents in Evacuation Areas)
  - **Pregnancy and Birth Survey** (pregnant women who have obtained a maternity handbook)

Prepared based on the website of the Radiation Medical Science Center for the Fukushima Health Management Survey, Fukushima Medical University

In the aftermath of the diffusion of radioactive materials from the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS, subsequent evacuations and such, the "Fukushima Health Management Survey" was commenced in Fukushima Prefecture, aiming to improve and maintain the health of the residents of the prefecture into the future by means of understanding their health conditions and linking such data to the prevention and early detection and treatment of diseases, while assessing their radiation doses.

Within the Fukushima Health Management Survey, the Basic Survey was offered to all residents of Fukushima Prefecture to ascertain their external doses during the four months following the accident at the NPS. Additionally, for all residents who were around 18 years old or younger at the time of the accident, the Thyroid Examination has been conducted. The Comprehensive Health Checkup to ascertain physical health conditions and the Mental Health and Lifestyle Survey to ascertain mental health conditions have also been conducted for approximately 210,000 people who were residing in areas designated for evacuation at the time of the accident. Furthermore, the Pregnancy and Birth Survey has been conducted every year for pregnant women who obtained a maternity handbook within Fukushima Prefecture and those who obtained a maternity handbook somewhere else but gave birth in the prefecture.

Included in this reference material on March 31, 2013

Updated on December 1, 2017

## Outline of the Fukushima Health Management Survey

# Fukushima Health Management Survey (Survey Promotion System)

### [Purpose of the Survey]

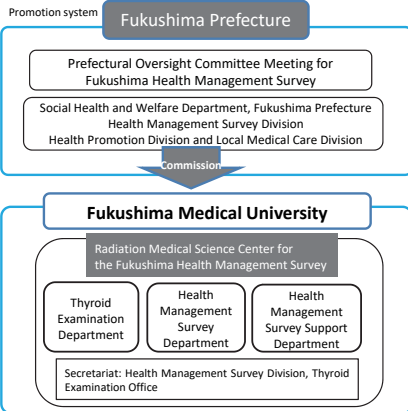
Considering the effects of radiation due to the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS, Fukushima Prefecture has commissioned Fukushima Medical University to conduct the "Fukushima Health Management Survey" for all residents of the prefecture in order to monitor and improve their health for the long term and ensure their safety and peace of mind.

By continuously conducting surveys and health checkups, the Survey aims to achieve the prevention and early detection and treatment of diseases and improve the health of residents into the future, while developing better systems for research, education and medical services.

### [Promotion system]

Under guidance and advice from qualified individuals comprising the Prefectural Oversight Committee Meeting for Fukushima Health Management Survey, Fukushima Prefecture and Fukushima Medical University have been jointly conducting the Survey.

Fukushima Medical University established the Radiation Medical Science Center for the Fukushima Health Management Survey in September 2011 and also established the Health Management Survey Division in April 2012 as a dedicated administrative office.



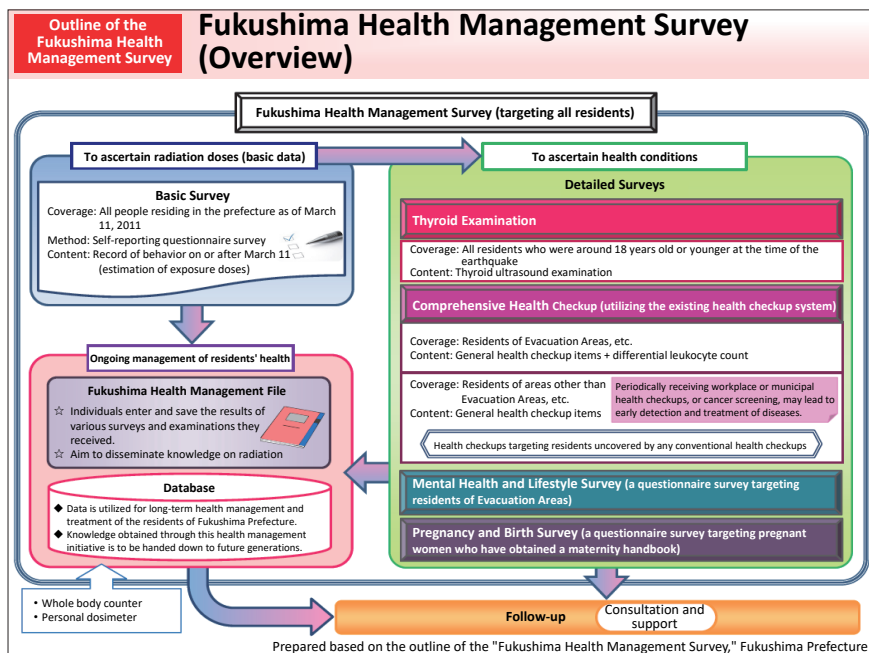
Prepared based on the outline of the "Fukushima Health Management Survey," Fukushima Prefecture

The Fukushima Health Management Survey is being carried out by Fukushima Medical University under commission from Fukushima Prefecture, which serves as the responsible entity. Fukushima Medical University established the Radiation Medical Science Center for the Fukushima Health Management Survey to carry out the Survey.

Fukushima Prefecture set up the Prefectural Oversight Committee Meeting for Fukushima Health Management Survey with the aim of obtaining advice on the Fukushima Health Management Survey from a broad panel of experts.

Included in this reference material on March 31, 2015

Updated on December1, 2017



The Fukushima Health Management Survey is broadly divided into the Basic Survey and Detailed Surveys.

The Basic Survey was conducted for the purpose of estimating residents' external doses for the four months after the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS based on their behavioral records and obtaining data that is to serve as the basis for monitoring and protecting their health into the future.

The Detailed Surveys are to ascertain residents' present health conditions, as follows:

The first is the Thyroid Examination targeting all residents who were around 18 years old or younger as of March 11, 2011. As cases of thyroid cancer increased among children after the Chernobyl accident, this examination is to be repeated periodically for the applicable participants.

The second is the Comprehensive Health Checkup targeting people who used to reside in Evacuation Areas, being conducted with the aim of achieving the prevention, early detection, and treatment of lifestyle-related diseases that may be caused by changes in their living circumstances.

The third is the Mental Health and Lifestyle Survey, which also targets people from Evacuation Areas. This is for offering support to the disaster victims to ease anxiety and emotional trauma caused by the Great East Japan Earthquake and the accident at the NPS.

The fourth is the Pregnancy and Birth Survey targeting pregnant women who have worries over various things including radiation fears in relation to childbirth and child rearing.

Individuals are encouraged to personally keep records of these surveys and examinations in a Fukushima Health Management File, which is delivered to all residents, and utilize the data for their own health management. Additionally, Fukushima Prefecture compiles all data into a centralized database for the long-term utilization of accumulated knowledge.

Included in this reference material on March 31, 2013

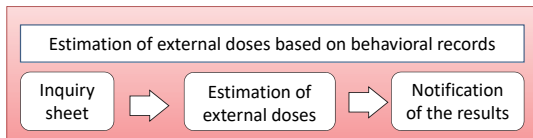
Updated on December 1, 2017

### A survey to obtain data that is to serve as the basis for monitoring and protecting residents' health

In order to estimate external doses, individuals were asked to keep and submit a record of their behavior.

Based on collected behavioral records for the four months from March 11 to July 11, 2011, each individual's external dose was estimated using the External Dose Estimation System developed by the National Institute of Radiological Sciences.

[Survey scheme]



Estimated results and the period for estimation are reported to participating individuals to let them know their own external doses, and at the same time, the obtained data are utilized in the Detailed Surveys and individuals' health management to be continued for the long term.

The 4th Expert Meeting on Communications with Nuclear Disaster Victims Regarding Their Health, Ministry of the Environment

The Basic Survey was conducted for the purpose of estimating the level of radiation exposure of people who were residing in Fukushima Prefecture at the time of the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS, and compiling data useful for individuals' health management into the future.

Specifically, inquiry sheets were delivered to the applicable residents to ask them to record their behavior during the four months after the accident. Based on the behavioral records entered in the inquiry sheets, individuals' external doses were estimated using a program developed by the National Institute of Radiological Sciences.

Individuals' estimated external doses were compiled and statistically processed, and have been utilized for analyzing radiation exposure and its health effects in Fukushima Prefecture.

Included in this reference material on March 31, 2013

Updated on December 1, 2017

**[Period for estimation]**

Behavior during the four months from March 11 to July 11, 2011

**[Coverage]**

Approx. 2.06 million people

- Residents of the prefecture:

People with residence registration in the prefecture from March 11 to July 1, 2011

- People residing outside the prefecture:

(1) People who were registered as residents in other prefectures but were residing in the prefecture from March 11 to July 1, 2011

(2) People residing outside the prefecture who commuted to work or school in the prefecture from March 11 to July 1, 2011

(3) People residing outside the prefecture who temporarily stayed in the prefecture from Mar. 11 to Mar. 25, 2011

(For people residing outside the prefecture, inquiry sheets were sent upon their request.)

The 4th Expert Meeting on Communications with Nuclear Disaster Victims Regarding Their Health, Ministry of the Environment

The period for surveying behavioral records was the four months from March 11 to July 11, 2011.

The Basic Survey covered approx. 2.06 million people who were registered as residents of the prefecture at the time of the earthquake. People residing outside the prefecture, for example, those registered as residents in other prefectures, were also covered if they resided, commuted to work or school, or temporarily stayed in the prefecture during this period.

Included in this reference material on March 31, 2013

Updated on March 31, 2017

# Basic Survey: Inquiry Sheets

In November 2013, a simplified inquiry sheet was introduced.

## ● Detailed version (conventional version)

年月日	場所	時間	活動	地名・施設名
3/11	自宅	9:00	起床	①自宅
3/11	移動	9:00	移動	②自宅
3/11	屋外	9:00	屋外	③自宅
3/12	移動	9:00	移動	④自宅
3/12	屋外	9:00	屋外	⑤自宅
3/13	移動	9:00	移動	⑥自宅
3/13	屋外	9:00	屋外	⑦自宅
3/14	移動	9:00	移動	⑧自宅
3/14	屋外	9:00	屋外	⑨自宅
3/15	移動	9:00	移動	⑩自宅
3/15	屋外	9:00	屋外	⑪自宅

All respondents were asked to record the activities they conducted on an hourly basis for the period from March 11 to March 25, but the simplified inquiry sheet allows some respondents to summarize their behavior and only enter basic behavioral patterns for a certain period of time.

## ● Simplified version

期 間	居 住 地 等
平成23年 3月11日	1 この期間の居住場所は、2ページで記載した住所と同じですか？ <input type="checkbox"/> 同じ <input type="checkbox"/> 避難先の住所 <input type="checkbox"/> 3月11日の住民票住所 <input type="checkbox"/> 現在住所 <input type="checkbox"/> 異なる (下記に記入ください)
月 日	2 居住地域の近くでの避難、早期にみる人界にいたる時間は、 1日あたりどのくらいでしたか？ <input type="checkbox"/> 0時間 <input type="checkbox"/> 1時間 <input type="checkbox"/> 2時間 <input type="checkbox"/> 3時間以上
月 日	3 定期的な外出先 (勤務先や学校など) はありましたか？ <input type="checkbox"/> はい (次の欄に記入してください) <input type="checkbox"/> いいえ (2ページ以降であれば、外出先と住所の記入は不要) 外出先施設名:
月 日	4 外出先での滞在時間は、1日あたりどのくらいでしたか？ 屋内 [ ] 時間 屋外 [ ] 時間 外出する頻度は？ (○で選択) 月・火・水・木・金・土・日 <input type="checkbox"/> はい <input type="checkbox"/> いいえ (次の欄に記入してください) 外出先施設名:
月 日	5 外出先での滞在時間は、1日あたりどのくらいでしたか？ 屋内 [ ] 時間 屋外 [ ] 時間 外出する頻度は？ (○で選択) 月・火・水・木・金・土・日

[Requirements for using the simplified inquiry sheet]

People who have experienced none or only one significant behavioral pattern change (such as a change of residence, school or workplace due to evacuation or moving) in the four months following the earthquake

## Examples

- 1 A person who was residing in Fukushima City at the time of the earthquake, evacuated to Kanagawa on March 15 and continued staying in Kanagawa until July 11
- 2 A person who was residing in Fukushima City at the time of the earthquake, evacuated to Aizuwakamatsu on March 15 but returned to Fukushima City on June 10

Moved once

Simplified version

Moved twice

Detailed version

Prepared based on the website of the Radiation Medical Science Center for the Fukushima Health Management Survey, Fukushima Medical University, "Information on the Fukushima Health Management Survey"

The original inquiry sheet for the Basic Survey required respondents to record the activities they conducted on an hourly basis for the period from March 11 to March 25. In response to complaints concerning the difficulty in filling in the sheet, a simplified version was introduced in November 2013.

However, in order to maintain the accuracy of the survey, there are requirements for using the simplified inquiry sheet. Only those who have experienced none or only one significant change in their living place due to evacuation or moving, etc. in the four months following the earthquake are allowed to use it.

Included in this reference material on March 31, 2013

Updated on March 31, 2016



## Basic Survey

# Basic Survey: Analysis Methods

## (Behavioral Pattern Survey and Dose Rate Map)

## Behavioral pattern survey

Examine behavioral patterns based on inquiry sheets of the Fukushima Health Management Survey

## Survey period

Four months from March 11 to July 11, 2011

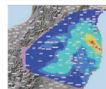
## Surveyed items

- Stays (places, hours and building structures)
- Moves (places and hours)

記入例	滞在場所	時間	地名・施設名
移動	① 自宅内	0 3 6 9 12 15 18 21 24	① 自宅
移動	② 避難所	③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩ ⑪ ⑫ ⑬ ⑭ ⑮ ⑯ ⑰ ⑱ ⑲ ⑳ ㉑ ㉒ ㉓ ㉔ ㉕ ㉖ ㉗ ㉘ ㉙ ㉚ ㉛ ㉜ ㉝ ㉞ ㉟ ㊱ ㊲ ㊳ ㊴ ㊵ ㊶ ㊷ ㊸ ㊹ ㊺	② 自宅の隣 ③ 車内 ④ 避難所 ⑤ 〇〇市 X X 中学校 ⑥ 〇〇市 X X 町立 A 小

## Dose rate maps

Prepare maps showing average daily effective dose rates based on data of SPEEDI and the Ministry of Education, Culture, Sports, Science and Technology (MEXT)



- March 12 to 14 Evaluation results by SPEEDI (effective dose rates)
- From March 15 onward Monitoring data released by MEXT (at that time) (ambient dose equivalent rates)

Convert ambient dose equivalent rates to effective dose rates by multiplying by 0.6

- Divide into 2 km × 2 km grids
- Interpolate discrete data using software to create a map

\* Values of natural radiation are not included.

## Calculation of cumulative effective doses

## Evaluate effective doses based on behavioral patterns and dose rate maps

Prepared based on the website of Fukushima Prefecture, "Estimation of External Doses (Outline of the External Dose Estimation System and Estimation Results by Model Pattern of Evacuation Behavior)", National Institute of Radiological Sciences" (December 13, 2011)

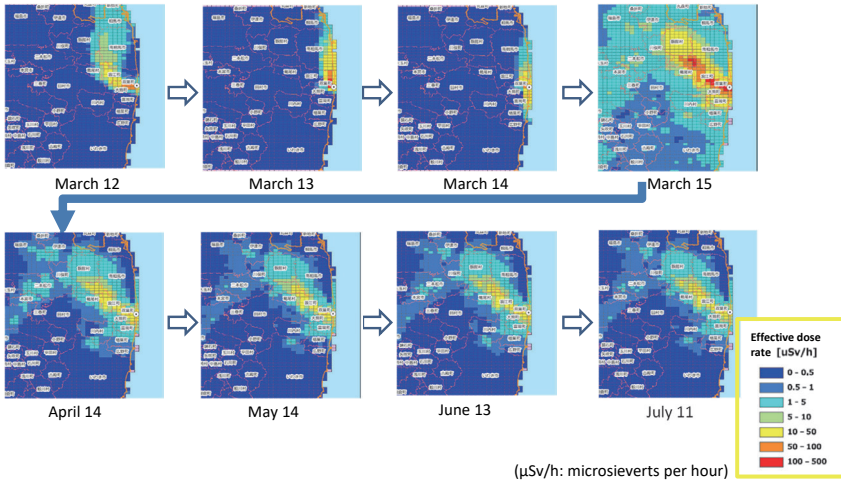
In the Basic Survey, external doses were evaluated combining the results of the behavioral pattern survey and the created dose rate maps. The evaluation was conducted based on dose rate maps and behavioral records entered by respondents, such as where and how long they stayed in buildings, and the type of buildings where they stayed, during the survey period.

Included in this reference material on March 31, 2013

Updated on March 31, 2016

## Basic Survey: Analysis Methods

### (Time-Series Dose Rate Maps)



Prepared based on the website of Fukushima Prefecture, "Estimation of External Doses (Outline of the External Dose Estimation System and Estimation Results by Model Pattern of Evacuation Behavior), National Institute of Radiological Sciences" (December 13, 2011)

Dose rate maps used here are the monitoring data released by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) (at that time).\*

\* For the three days from March 12 to March 14, which are included in the period (March 12 to March 15, 2011) during which the monitoring data released by MEXT (at that time) is not available, calculation results by SPEEDI (System for Prediction of Environmental Emergency Dose Information) using the data on radioactive material discharge released by the Nuclear and Industrial Safety Agency (at that time) in June 2011 were applied. Data for March 15 was assumed to be the same as that for March 16, and from March 16 onward, the monitoring data released by MEXT (at that time) was used.

Included in this reference material on March 31, 2013

Updated on March 31, 2016

## The response rate was 27.6% for the entirety of Fukushima Prefecture

Table 1 Responses to the Basic Survey

As of June 30, 2017

Coverage		2,055,258	
Number of responses	Detailed version	493,584	24.0%
	Simplified version	73,189	3.6%
	Total	566,773	27.6%

\* Response rates are rounded off for each category.

Table 2

Response rate by age bracket

As of Jun. 30, 2017

Age bracket	0-9	10-19	20-29	30-39	40-49	50-49	60-	Total
Response rate	46.6%	35.8%	18.1%	24.7%	22.4%	23.0%	27.9%	27.6%

Material for the 28th Prefectural Oversight Committee Meeting for Fukushima Health Management Survey

During the survey period, i.e., the four months from March 12 to July 11, 2011, ambient dose rates were especially high and ascertaining people's external doses during this period is most important.

Approx. 566,773 people have made responses so far (response rate: 27.6%).

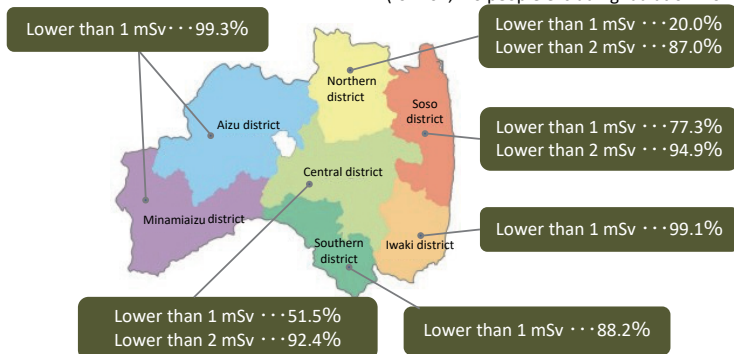
Thanks to the introduction of the simplified inquiry sheet and assistance for filling in the inquiry sheet offered at venues of the Thyroid Examination, the response rate improved, mainly among young people.

Included in this reference material on March 31, 2013

Updated on December 1, 2017

## Results of estimated external effective doses by district

(for 464,420 people excluding radiation workers)



## Evaluation of estimated effective doses

Past epidemiological studies have not confirmed clear health effects of radiation below 100 mSv. Therefore, the estimated external effective doses, though covering only four months, can be evaluated as values that are unlikely to show any health effects caused by radiation.

Prepared based on the material for the 28th Prefectural Oversight Committee Meeting for Fukushima Health Management Survey

Out of a total of 552,298 people for whom external effective doses have been estimated by June 30, 2017, a total of 473,605 people submitted records of their behavior for the entirety of the four-month period for estimation. The figure above shows the estimation results of 464,420 people, excluding those who had engaged in radiation work, by district. As shown in the figure, people for whom estimated external effective doses were lower than 1 mSv accounted for 88.2% in the southern district, 99.3% in the Aizu and Minamiaizu districts, 77.3% in the Soso district, and 99.1% in the Iwaki district. The maximum value was 25 mSv estimated for a person residing in the Soso district.

Included in this reference material on March 31, 2013

Updated on December 1, 2017

## [Purpose]

In light of the fact that the response rate of the Basic Survey was approximately 27%, this examination aims to ascertain whether the dose distribution based on the data obtained so far through the Basic Survey correctly reflects the actual status for all residents of the prefecture and is not biased (representativeness of the dose distribution).

## [Method]

In FY2015, a group of people was selected at random for each of the seven districts in the prefecture, and the selected people were classified into those who had already responded to the Basic Survey and those who had not in each district. Staff visited people who had not responded to the Basic Survey to ask them to make responses, and a comparison was made between estimated doses for these people and estimated doses for people who had responded to the Basic Survey earlier.

## [Results]

In each district, the dose distribution based on the data obtained so far was found to be unbiased and to properly represent respective districts.

Prepared based on the material for the 22nd Prefectural Oversight Committee Meeting for Fukushima Health Management Survey

## &lt; Method &gt;

In FY2015, a group of people was selected at random for each of the seven districts in the prefecture, and the selected people were classified into those who had already responded to the Basic Survey and those who had not in each district. Staff visited people who had not responded to the Basic Survey to ask them to make responses, and a comparison was made between estimated doses for these people and estimated doses for people who had responded to the Basic Survey earlier.

For districts with wider dose distribution being ascertained so far, a larger number of people were selected at random.

A statistical comparison was made between estimated doses for people who had responded to the Basic Survey earlier and those for people who had not responded to the Basic Survey but provided responses upon this door-to-door examination.

## &lt; Results &gt;

As a result of a statistical analysis, average doses for both groups (people who had responded to the Basic Survey earlier and people who provided responses upon this door-to-door examination) differ only by  $\pm 0.25$  mSv at the most and it was found that estimated external doses for both groups were at the same level.

See the following website for details:

① -5 and ① -6: <http://www.pref.fukushima.lg.jp/uploaded/attachment/151271.pdf> (in Japanese)

Included in this reference material on March 31, 2016

Updated on December 1, 2017

## "We will promote the health of the children in Fukushima for the long term."

### [Purpose]

Health effects of radiation due to the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS are considered to be extremely small, taking into consideration the expected internal and external exposure doses.

On the other hand, it has been reported that cases of thyroid cancer increased among children after the Chernobyl accident due to internal exposure to radioactive iodine. Therefore, the Thyroid Examination targeting children has been conducted since October 2011 with the aim of ascertaining their thyroid status and promoting their health for the long term.

### [Coverage]

All people of Fukushima Prefecture who were aged zero to 18 as of March 11, 2011 (those born from April 2, 1992, to April 1, 2011) (approx. 368,000 people)

- \* The Full-scale Screening expanded coverage to include those born from April 2, 2011, to April 1, 2012 (approx. 382,000 people in total).

Prepared based on the website of the Radiation Medical Science Center for the Fukushima Health Management Survey, Fukushima Medical University, "Information on the Thyroid Examination"

It has been reported that cases of thyroid cancer increased among children after the Chernobyl accident due to internal exposure to radioactive iodine. Compared with the Chernobyl accident, the amount of radioactive materials discharged into the environment after the accident in Fukushima was much smaller and estimated internal and external doses of the residents were even smaller. Therefore, it is predicted that there would be no epidemiologically detectable thyroid health risks. However, as concerns remain about effects of radiation due to the accident on children's thyroid glands, the Thyroid Examination has been continued under the framework of the Fukushima Health Management Survey with the aim of ascertaining children's current thyroid status and promoting their health into the future.

Included in this reference material on March 31, 2013

Updated on March 31, 2017

## ● Coverage and examination plan

	Screening category	Period	Coverage
First examination	<b>Initial Screening</b> (In order to ascertain children's thyroid status)	Oct. 2011 - March 2014	Residents who were residing in Fukushima Prefecture at the time of the earthquake and were approximately 18 years old or younger (those born from April 2, 1992, to April 1, 2011)
Second examination	<b>Full-scale Screening</b> (In order to make comparison with the results of the Initial Screening)	April 2014 - March 2016	In addition to those covered by the Initial Screening, those born from April 2, 2011, to April 1, 2012
<b>Third examination</b>		April 2016 - March 2018	In principle, those born from April 2, 1992, to April 1, 2012
Fourth examination -		Once every two years until becoming 20 years old, then once every five years after becoming 25 years old, for example, at the ages of 30, 35 and so on	

Prepared based on the website of the Radiation Medical Science Center for the Fukushima Health Management Survey, Fukushima Medical University, "Information on the Thyroid Examination"

Ascertaining the current thyroid status of the relevant group of people even though radiation effects are unlikely to be detected is very important for promoting their health for the long term. Therefore, the Thyroid Examination was conducted for all children in Fukushima Prefecture after the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS over a period of approximately two and a half years from October 2011 (Initial Screening).

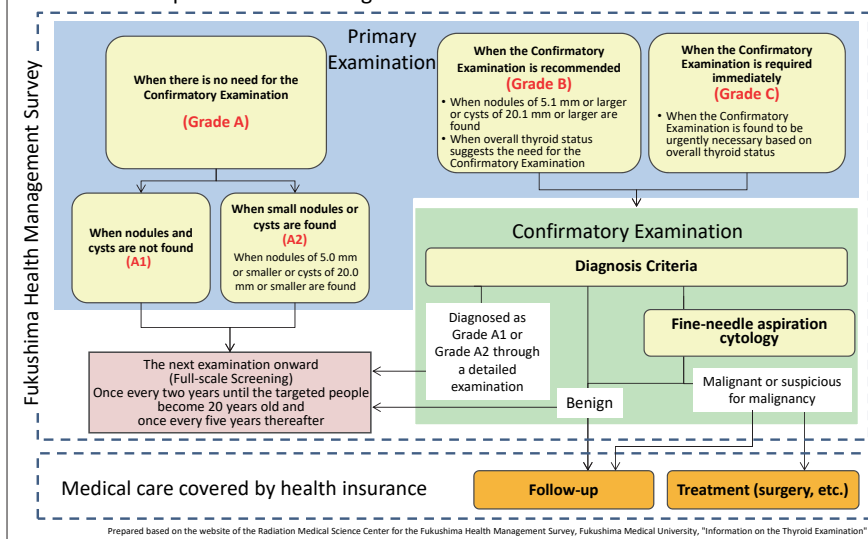
Then, in FY2014, the coverage was expanded to include those born from April 2, 2011, to April 1, 2012, and the Full-scale Screening was conducted as the second examination.

From the third examination onward, the targeted people receive examinations once every two years until they become 20 years old and once every five years thereafter.

Included in this reference material on March 31, 2013

Updated on December 1, 2017

## ● Examination procedures and diagnosis criteria



This shows the procedures for the Thyroid Examination.

The Primary Examination checks whether there are any nodules or cysts and measures the sizes thereof, if any. The Confirmatory Examination is recommended to those who are considered to require a more detailed examination.

In the Confirmatory Examination, a more accurate ultrasound examination, plus blood and urine tests are conducted, and fine-needle aspiration cytology is also conducted when a doctor considers it necessary.

The Thyroid Examination is completed at this point.

Then, individuals who are found to require treatment receive it from their regular healthcare provider, under the relevant medical insurance system.

Included in this reference material on March 31, 2016

Updated on December 1, 2017



### ● Content of the examination

#### [Primary Examination]

An ultrasound examination assesses whether there are any nodules or cysts. The examination ordinarily finishes in three to five minutes with no pain involved.

The diagnosis panel, consisting of medical specialists, reviews the ultrasound images and makes diagnoses. The examination results are sent by post, but explanations are given at the examination venues or by phone upon examinees' requests.



#### [Confirmatory Examination]

When a more detailed examination is found to be necessary as a result of the Primary Examination, the Confirmatory Examination is conducted for the relevant person. In the Confirmatory Examination, another ultrasound examination, plus blood and urine tests are conducted.

If a doctor considers it necessary as a result of these tests, fine-needle aspiration cytology of the thyroid may also be performed and interpreted.

Prepared based on the website of the Radiation Medical Science Center for the Fukushima Health Management Survey, Fukushima Medical University, "Information on the Thyroid Examination"

An ultrasound examination is conducted with an examinee lying on his/her back. A doctor places an ultrasonic probe with jelly on its tip over the examinee's thyroid (located around the base of the neck) and searches for cysts and nodules while moving the probe over the examinee's skin.

The examination ordinarily finishes in three to five minutes with no pain involved.

Definitive diagnoses from the Primary Examination are not made at the venues. In order to make comprehensive and objective judgments, ultrasound images are later reviewed by a panel of medical specialists. This is to ensure a consistently high level of diagnostic accuracy throughout the Fukushima Health Management Survey.

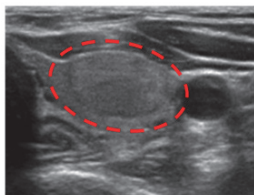
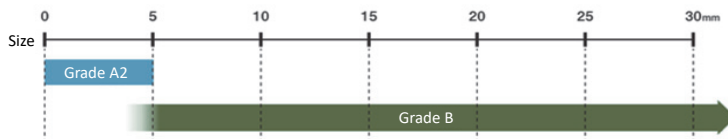
The sizes of nodules and cysts mentioned above are reference values for making diagnoses. If any nodules or cysts found in ultrasound images are suspected to be malignant, the case is designated as Grade B irrespective of the sizes of the nodules or cysts and the Confirmatory Examination is recommended.

In the Confirmatory Examination, a more accurate ultrasound examination, plus blood and urine tests, are conducted. If, as a result of these tests, a doctor considers it necessary, fine-needle aspiration cytology, an examination of a sample tissue taken from the person's thyroid, may also be conducted.

Included in this reference material on March 31, 2016

Updated on March 31, 2017

A nodule, which might also be called a lump, is an irregular growth of thyroid cells.



- Nodules may be malignant (cancerous), but most are benign.

< Thyroid cancer >

- In many cases, latent thyroid cancer has no symptoms or health effects over a lifetime.
- Latent thyroid cancer is usually small. It may be disadvantageous to force patients to receive treatment if such a cancer is found incidentally.
- Therefore, a detailed examination is not generally conducted for small nodules.

< Thyroid Examination conducted in the Fukushima Health Management Survey >

- The Confirmatory Examination is not conducted for nodules of 5 mm or smaller and follow-ups are to be made at the time of the next examination.
- However, when a detailed examination is found to be necessary, a case with nodules of 5 mm or smaller is diagnosed as Grade B and the Confirmatory Examination is recommended.

Prepared based on the website of the Radiation Medical Science Center for the Fukushima Health Management Survey, Fukushima Medical University, "Q&A on the Thyroid Examination"

A nodule, which might also be called a lump, is an irregular growth of thyroid cells. Some nodules are malignant, but most are benign.

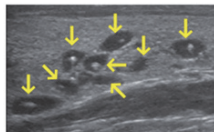
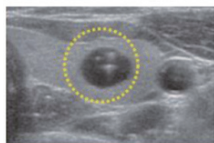
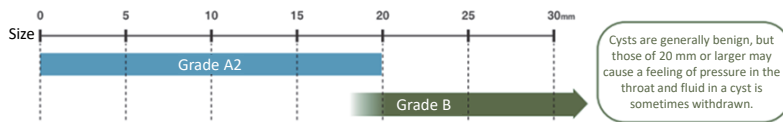
Thyroid cancer has been known as a type of cancer that is latent, that is, having no symptoms or health effects over a lifetime. Thus, detecting all cancers and forcing patients to receive treatment may be sometimes rather disadvantageous, so a detailed examination, such as cytological diagnosis, is not generally conducted for small nodules. In the Thyroid Examination conducted through the Fukushima Health Management Survey, the Confirmatory Examination is not generally performed for nodules of 5 mm or smaller; instead, follow-ups are to be made at the time of the next regularly scheduled ultrasound examination (Primary Examination).

In some cases, a person once diagnosed as Grade A1 is diagnosed as Grade A2 or Grade B in the next examination, or conversely, a person once diagnosed as Grade A2 is subsequently diagnosed as Grade A1.

Included in this reference material on March 31, 2013

Updated on March 31, 2017

A cyst, which resembles a bag filled with fluid, is generally benign, and is often found even in healthy people.



- Cysts often change in size or number.
- Many people have multiple cysts, and the estimated size of the largest one is told to each examinee in this examination.
- Cysts consisting only of fluid and containing no cells are not cancerous.
- Cysts found in the latest examination were all deemed to be benign.
- Cysts are seldom found in babies and infants but are rather found in primary and secondary school students.

Prepared based on the website of the Radiation Medical Science Center for the Fukushima Health Management Survey, Fukushima Medical University, "Q&A on the Thyroid Examination"

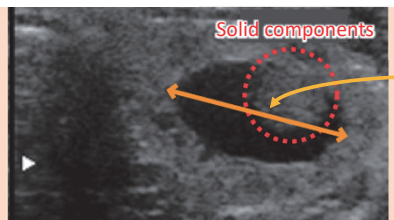
Cysts identified in the Thyroid Examination being conducted in Fukushima Prefecture are considered benign, consisting only of fluid and containing no cells. They are often found even in healthy people, especially among primary and secondary school students. Therefore, repeated examinations often find cysts as children grow up.

Included in this reference material on March 31, 2013

Updated on March 31, 2017

## Thyroid Examination: Handling of Cysts with Solid Components

**Cysts with solid components are all judged as nodules.**



Measure the entirety of a cyst

When the maximum size of a cyst with solid components (the length of the orange arrow) is 5.1 mm or larger, the examinee is diagnosed as Grade B.

- Cysts partially containing solid components (cells) are called cystic nodules or cysts with solid components.
- They are treated as equivalents to ordinary cysts in general medical examinations. Even when the Confirmatory Examination is conducted, they are deemed unlikely to cause problems and are placed under follow-up observations.

Prepared based on the website of the Radiation Medical Science Center for the Fukushima Health Management Survey, Fukushima Medical University, "Q&A on the Thyroid Examination"

Some cysts contain nodules. In the Thyroid Examination conducted in the Fukushima Health Management Survey, those cysts with solid components (nodules) are all judged as nodules and diagnosis criteria for nodules are applied.

For example, a 10 mm-cyst with a 4 mm-nodule is judged as a nodule and diagnosis criteria for nodules are applied. As the size is larger than 5.1 mm, the examinee is diagnosed as Grade B and is advised to receive the Confirmatory Examination.

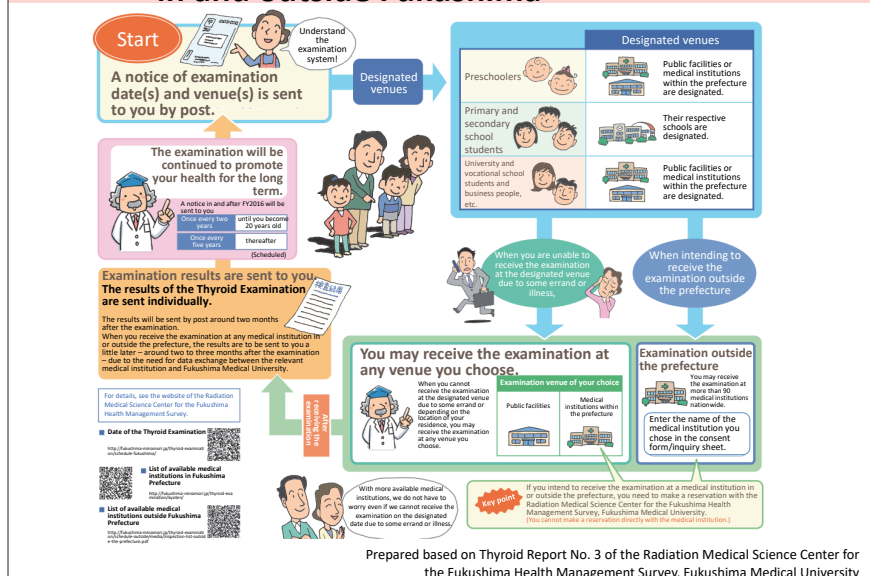
Items judged as fluid-only cysts are considered to be benign.

(Related to P.121, Vol. 2, "Thyroid Examination: Cysts")

Included in this reference material on March 31, 2016

Updated on March 31, 2017

# Thyroid Examination: System for Examinations in and outside Fukushima



The Thyroid Examination is conducted in collaboration between Fukushima Medical University and medical institutions in and outside Fukushima Prefecture. For more convenience to residents of the prefecture, efforts have been made to increase venues and opportunities with the aim of properly promoting the health of the people in Fukushima Prefecture for the long term.

Included in this reference material on March 31, 2015



Updated on March 31, 2017

## Thyroid Examination: Order of Full-scale Screening





The examination has been conducted sequentially, starting in areas where ambient dose rates were highest after the disaster.

- The first Full-scale Screening (the second one after the Initial Screening)

 Municipalities where the FY2014 Primary Examination was conducted (25 municipalities)  
 Municipalities where the FY2015 Primary Examination was conducted (34 municipalities)

- The second Full-scale Screening (the third one after the Initial Screening)

 Municipalities where the FY2016 Primary Examination was conducted (25 municipalities)  
 Municipalities where the FY2017 Primary Examination was conducted (34 municipalities)

Materials for the 22nd and 24th Prefectural Oversight Committee Meetings for Fukushima Health Management Survey

The Thyroid Examination has been conducted sequentially, starting in areas where ambient dose rates were highest at the time of the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS.

After the first Full-scale Screening, which was the second one after the Initial Screening, notices of the examination have been sent mostly in the same order so that the interval from the Initial Screening would not be prolonged. Since FY2016, the examination for those aged 20 or older has come to be conducted once every five years, but the examination plan is designed so that all targeted people will receive examinations regularly without more than a five-year gap between examinations through age 25.

Included in this reference material on March 31, 2015

Updated on December 1, 2017

## ● Results of the Primary Examination

Results of the Primary Examination								
	Coverage (people)	Examinees (people)		Diagnosis rate (%)	Number of those diagnosed (people)			
		Percentage of examinees (%)	Those who received the examination outside the prefecture		Breakdown by grade (%)			
					A		Those requiring the Confirmatory Examination	
					A1	A2	B	C
Total	367,649	300,473 (81.7)	9,511	300,473 (100.0)	154,605(51.5)	143,574 (47.8)	2,293(0.8)	1 (0.0)

## ● Number and percentage of those having nodules or cysts

Grade A: 99.2%

	Number of those with determined results (people)	Number of those having nodules or cysts against number of those with determined results (%)			
		Nodules		Cysts	
		5.1 mm or larger	5.0 mm or smaller	20.1 mm or larger	20.0 mm or smaller
Total	300,473	2,275 (0.8)	1,713 (0.6)	12 (0.0)	143,899 (47.9)

Grade B

\* Even when nodules were 5.0 mm or smaller or cysts were 20.0 mm or smaller, the relevant examinee may be diagnosed as Grade B depending on other factors.

## ● Results of the Confirmatory Examination

	Coverage (people)	Examinees (people)	Percentage of examinees (%)	Determination rate (%)	Number of those with determined results (people)			
					Next examination		Regular healthcare program, etc.	
					A 1	A 2	Those who received fine-needle aspiration cytology	
Total	2,293	2,130 (92.9)	2,090 (98.1)	132 (6.3)	579 (27.7)	1,379 (66.0)	547 (39.7)	

## ● Results of the fine-needle aspiration cytology

Malignant or suspicious for malignancy: 116 people; 39 males and 77 females

Average age: 17.3 ± 2.7 years old (8 to 22 years old); At the time of the earthquake: 14.9 ± 2.6 years old (6 to 18 years old)

Average tumor size: 13.9 ± 7.8 mm (5.1 to 45.0 mm)

- Out of 116 people whose tumors were diagnosed as malignant or suspicious for malignancy, 102 people had surgery (benign nodule: 1; papillary cancer: 100; poorly differentiated cancer: 1).

Prepared based on the material for the 27th Prefectural Oversight Committee Meeting for Fukushima Health Management Survey

These are the final results of the Initial Screening, which was the very first Thyroid Examination.

Examinees diagnosed as Grade A in the Primary Examination accounted for 99.2% of the total, while those diagnosed as Grade B accounted for 0.8%. It became clear that most of those diagnosed as Grade A2 had cysts of 20 mm or smaller and that those diagnosed as Grade B had nodules of 5.1 mm or larger.

In the Confirmatory Examination, as a result of a more accurate ultrasound examination and other tests, 34%, or approximately one out of three who received the Confirmatory Examination, were diagnosed as being equivalent to Grade A and were recommended to receive the next periodic examination in the same manner as those diagnosed as Grade A in the Primary Examination. This is because those who were suspected to have any abnormalities were diagnosed as Grade B just to be safe in the Primary Examination, and such people include those eventually diagnosed as Grade A in the Confirmatory Examination as a result of comprehensive and objective judgments through a more detailed examination, etc.

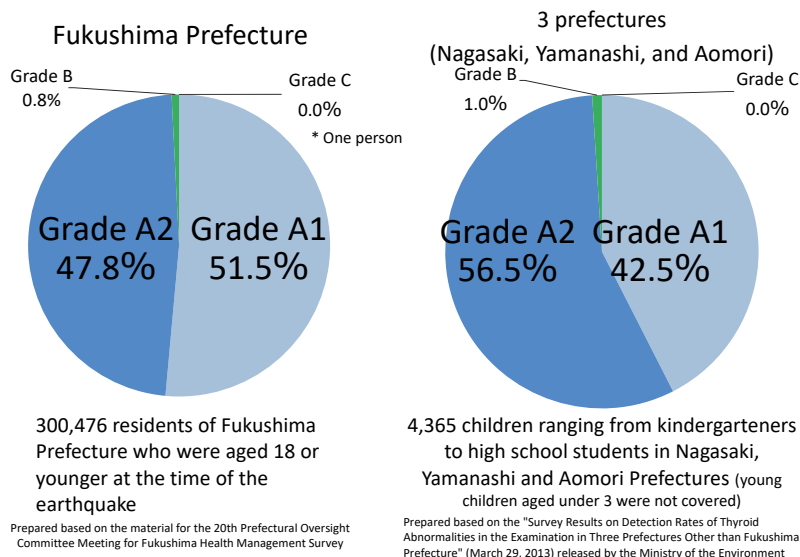
Among the examinees receiving the Confirmatory Examination, 66% were shifted to ordinary medical care covered by health insurance and most of them have been advised to receive another thyroid examination six months to one year later, as determined by the responsible doctor, based on individual findings and circumstances.

Furthermore, 39.7% received fine-needle aspiration cytology, and out of 116 examinees whose tumors were diagnosed as malignant or suspicious for malignancy, 102 had surgery. It is not that all patients whose tumors are diagnosed as malignant or suspicious for malignancy have surgery. Whether to have surgery or not is decided depending on the individuals' situations on a case-by-case basis through consultations among doctors in charge, patients themselves, and their families.

Included in this reference material on March 31, 2016

Updated on December 1, 2017

## Thyroid Examination: Comparison between the Initial Screening and the Examination in Other Prefectures



When the Thyroid Examination commenced, many people were concerned about a relatively high percentage of examinees diagnosed as Grade A2. Therefore, in FY2012, the Ministry of the Environment (MOE) conducted the Thyroid Examination targeting approx. 4,300 children in Nagasaki, Yamanashi and Aomori Prefectures (3-prefecture examination) in the same manner as the examination conducted in Fukushima Prefecture.

The examination in Fukushima Prefecture covered children aged zero to 18, while the 3-prefecture examination excluded children aged under 3 and covered only those aged 3 to 18. As the cohort was much smaller in the 3-prefecture examination, a simple comparison cannot be made, but the results show that those diagnosed as Grade A2 were not greater in number among the children of Fukushima Prefecture. The figures above show that the percentage of those diagnosed as Grade A2 in Fukushima Prefecture was actually smaller by 9 points than in the three prefectures and, conversely, the percentage of those diagnosed as Grade A1 was larger by 9 points. The report of the 3-prefecture examination made the following observations: "It is generally known that the detection rate of nodular lesions is lower in the group of examinees aged 3 to 5 than in the group of examinees aged 6 or older, and that females show higher detection rate than males. Therefore, there is the possibility that a detection rate tabulated based on simple descriptive statistical methods as in this case may be higher than the actual rate."\* The gaps in the percentages of those diagnosed as Grade A1 and Grade A2 between the examination in Fukushima Prefecture and the 3-prefecture examination are considered to be due to differences in the cohort sizes and examinees' ages (the 3-prefecture examination excluded children aged under 3).

\* Source: "Report on the Outcome of the FY2012 Survey on Detection Rates of Thyroid Abnormalities" (commissioned by MOE), The Japan Association of Breast and Thyroid Sonology (March 2013)

Included in this reference material on March 31, 2014  
Updated on December 1, 2017



● Results of the Primary Examination

Results of the Primary Examination								
	Coverage (people)	Examinees (people)		Diagnosis rate (%)	Number of those diagnosed (people)			
		Percentage of examinees (%)	Those who received the examination outside the prefecture		Breakdown by grade (%)			
					A		Those requiring the Confirmatory Examination	
					A 1	A 2	B	C
Total	381,256	270,516(71.0)	15,647	270,515 (100.0)	108,710(40.2)	159,578(59.0)	2,227(0.8)	0 (0.0)

● Number and percentage of those having nodules or cysts Grade A: 99.2%

	Number of those with determined results (people)	Number of those having nodules or cysts against number of those with determined results (%)			
		Nodules		Cysts	
		5.1 mm or larger	5.0 mm or smaller	20.1 mm or larger	20.0 mm or smaller
Total	270,515	2,219(0.8)	1,570(0.6)	6 (0.0)	160,357(59.3)

● Results of the Confirmatory Examination

	Coverage (people)	Examinees (people)	Determination rate (%)	Number of those with determined results (people)			
				Next examination		Regular healthcare program, etc.	
				A1	A2	Those who received fine-needle aspiration cytology	
Total	2,227	1,844(82.8)	1,788(97.0)	63(3.5)	360(20.1)	1,365(76.3)	205(15.0)

● Results of the fine-needle aspiration cytology

Malignant or suspicious for malignancy: 71people; 32 males and 39 females

Average age:  $16.9 \pm 3.3$  years old (9 to 23 years old); At the time of the earthquake:  $12.6 \pm 3.3$  years old (5 to 18 years old)

Average tumor size:  $11.1 \pm 5.7$  mm (5.3 to 35.6 mm)

- Out of 71 people whose tumors were diagnosed as malignant or suspicious for malignancy, 50 people had surgery (papillary cancer: 49; other types of thyroid cancer: 1).

Prepared based on the material for the 28th Prefectural Oversight Committee Meeting for Fukushima Health Management Survey

These are the interim results of the Full-scale Screening, which was the second round of the Thyroid Examination.

Examinees diagnosed as Grade A in the Primary Examination accounted for 99.2% of the total, while those diagnosed as Grade B accounted for 0.8%. Most of those diagnosed as Grade A2 had cysts of 20 mm or smaller and those diagnosed as Grade B had nodules of 5.1 mm or larger. This tendency was the same as that observed in the Initial Screening.

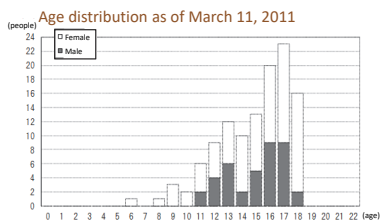
In the Confirmatory Examination, as a result of fine-needle aspiration cytology, 71examinees were diagnosed that their tumors were malignant or suspicious for malignancy.

Included in this reference material on March 31, 2016

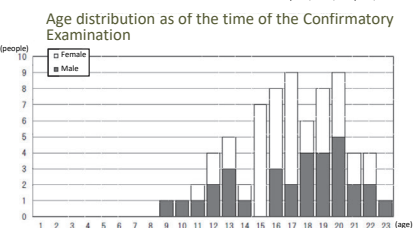
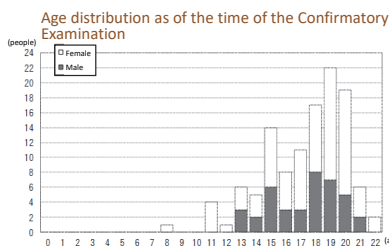
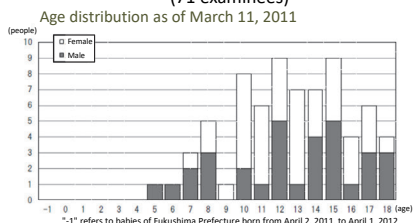
Updated on December 1, 2017

- Age distribution of examinees whose tumors were diagnosed as malignant or suspicious for malignancy as a result of fine-needle aspiration cytology

Results of the Initial Screening (116 examinees)



Results of the Full-scale Screening (2nd examination) (71 examinees)



Materials for the 27th and 28th Prefectural Oversight Committee Meetings for Fukushima Health Management Survey

These graphs show the age distribution, as of March 11, 2011, of examinees who subsequently had thyroid lesions diagnosed as malignant or suspicious for malignancy by fine-needle aspiration cytology, and their ages at the time of the Confirmatory Examination. So far, the situation is that thyroid cancer is not found more frequently among young children (aged zero to 5), who are considered to have higher sensitivity to radiation, than among people in the other age brackets.

These are only interim results and will be updated later.

Included in this reference material on March 31, 2014

Updated on December 1, 2017

## Thyroid Examination: Remarks on the Results of the Initial Screening

- The Thyroid Examination, which had no precedent for childhood screening, revealed thyroid cancers that might have otherwise gone unnoticed.

Percentage of examinees whose tumors were diagnosed as malignant or suspicious for malignancy as a result of fine-needle aspiration cytology (against the total examinees of the Primary Examination)

FY2011	FY2012	FY2013
0.03%	0.04%	0.04%

Material for the 20th Prefectural Oversight Committee Meeting for Fukushima Health Management Survey

- Evaluation of thyroid cancers found in the Initial Screening, the Interim Report by the Prefectural Oversight Committee Meeting for Fukushima Health Management Survey (March 2016)

"Comprehensively considering that: exposure doses due to the accident at the Fukushima Daiichi NPS were generally lower than those caused by the Chernobyl accident; the period of time from the exposure to the detection of cancers is short (mostly from one to four years); cancers have not been detected in those aged 5 or younger at the time of the accident; and there is no significant regional difference in detection rates, it can be concluded that thyroid cancers found so far through the Thyroid Examination cannot be attributed to radiation discharged due to the accident.

However, the possibility of radiation effects may be small but cannot be completely denied at this point in time. Additionally, it is necessary to accumulate information in the long term for accurate evaluation of the effects. Therefore, the Thyroid Examination should be continued, while meticulously explaining the disadvantages of receiving the examination and obtaining the understanding of examinees."

- The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) reiterated in its 2015 White paper\* that excessive thyroid cancer risks due to radiation exposure do not need to be taken into consideration.

\*Developments since the 2013 UNSCEAR Report on the levels and effects of radiation exposure due to the nuclear accident following the great east-Japan earthquake and tsunami (A 2015 White Paper to guide the Scientific Committee's future programme of work)

**In order to ascertain radiation effects, it is necessary to monitor developments over a long term.  
Please receive the examination continuously from the viewpoint of managing your own health as well.**

Thyroid cancers found so far through the Thyroid Examination being conducted in Fukushima Prefecture are considered to be unrelated to the radiation discharged due to the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS.

This evaluation is based on a comprehensive judgment of the following facts:

- Exposure doses due to the accident at the Fukushima Daiichi NPS were generally lower compared with those caused by the Chernobyl accident.
- The period of time from the exposure to the detection of cancers is short, mostly from one to four years.
- Cancers have not been detected in those who were 5 years old or younger at the time of the accident.
- Age distribution of patients significantly differs in Fukushima Prefecture and Chernobyl (p.132 of Vol. 1, "Comparison between the Chernobyl Accident and the Accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS (Ages at the Time of Radiation Exposure)").
- There are no significant differences in detection rates among different regions.

However, it is necessary to monitor developments over a long term to ascertain radiation effects, so the Thyroid Examination program should continue.

Included in this reference material on March 31, 2015

Updated on March 31, 2017

**"We will promote the health of the residents who were forced to evacuate."**

Due to the Great East Japan Earthquake and the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS, many of the residents of Fukushima Prefecture were forced to evacuate and face drastic changes in their daily lives. Accordingly, many may have also experienced significant changes in their diet, exercise, or other lifestyle factors or have had difficulty in receiving medical checkups, and are worried about their own health.

Fukushima Prefecture has been conducting health checkups for people who were residing in Evacuation Areas, such as Restricted Areas, designated by the national government as of 2011 ("covered areas"), considering it necessary to ascertain the overall health conditions of the residents, not limited to the health effects caused by their anxieties over radiation and prolonged refugee life, and to utilize the obtained data for the prevention and early detection and treatment of lifestyle-related diseases, thereby promoting and maintaining the good health of the residents.

Prepared based on the website of the Radiation Medical Science Center for the Fukushima Health Management Survey, Fukushima Medical University, "Information on the Comprehensive Health Checkup"

The residents who were forced to evacuate from covered areas have been living as refugees away from their own homes for a prolonged period of time. Fukushima Prefecture has been conducting the Comprehensive Health Checkup for the purpose of monitoring whether they have any physical problems and utilizing the data for early treatment as necessary.

Included in this reference material on March 31, 2013

Updated on December 1, 2017

## [Check items]

Age bracket	Check items
<b>Aged zero to 6</b> (babies and preschoolers)	Body height and weight [Only when requested] Blood counts (red blood cell count, hematocrit, hemoglobin, platelet count, white blood cell count, and differential white blood cell count)
<b>Aged 7 to 15</b> (first to ninth grade students)	Body height, weight, blood pressure, and blood counts (red blood cell count, hematocrit, hemoglobin, platelet count, white blood cell count, and differential white blood cell count) [Only when requested] Blood biochemistry (AST, ALT, γ-GT, TG, HDL-C, LDL-C, HbA1c, blood sugar, serum creatinine, and uric acid)
<b>Aged 16 or older</b>	Body height, weight, abdominal girth, body mass index (BMI), blood pressure, and <b>blood counts (red blood cell count, hematocrit, hemoglobin, platelet count, white blood cell count, and differential white blood cell count)</b> Urine test (uric protein, uric sugar, and <b>uric blood</b> ) Blood biochemistry (AST, ALT, γ-GT, TG, HDL-C, LDL-C, HbA1c, blood sugar, <b>serum creatinine, eGFR, and uric acid</b> ) <small>* Items in red letters are additional items that are not ordinarily checked in the specified health checkups.</small>

## [Coverage]

Residents who were registered at any of the municipalities designated as Restricted Areas, Deliberate Evacuation Areas or Evacuation-Prepared Areas in Case of Emergency or at any of the areas containing Specific Spots Recommended for Evacuation as of 2011 (approx. 210,000 people) and residents who were found to require the Comprehensive Health Checkup as a result of the Basic Survey (= The entire areas of Tamura City, Minamisoma City, Kawamata Town, Hirono Town, Naraha Town, Tomioka Town, Kawauchi Village, Okuma Town, Futaba Town, Namie Town, Katsurao Village and Iitate Village, and parts of Date City)

Prepared based on the website of the Radiation Medical Science Center for the Fukushima Health Management Survey, Fukushima Medical University, "Information on the Comprehensive Health Checkup"

Check items are those for ordinary health checkups plus blood counts, serum creatinine, urine occult blood, etc.

In the Specific Health Checkup targeting people aged 16 or older conducted by municipalities excluding Date City, items for ordinary health checkups plus those in red letters are checked.

The Comprehensive Health Checkup covers people who were residing in any of the municipalities designated as Restricted Areas, Deliberate Evacuation Areas or Evacuation-Prepared Areas in Case of Emergency or in any of the areas containing Specific Spots Recommended for Evacuation\* at the time of the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS.

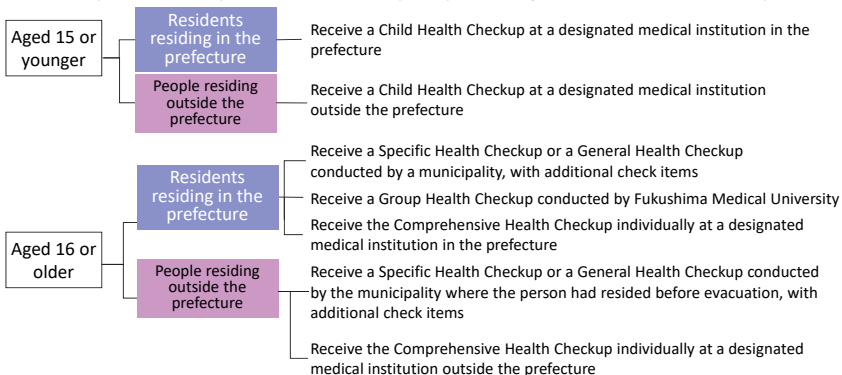
\* The entire areas of Tamura City, Minamisoma City, Kawamata Town, Hirono Town, Naraha Town, Tomioka Town, Kawauchi Village, Okuma Town, Futaba Town, Namie Town, Katsurao Village and Iitate Village, and parts of Date City

Included in this reference material on March 31, 2013

Updated on March 31, 2017

Every year, the Comprehensive Health Checkup is conducted at designated medical institutions individually for all children aged 15 or younger and people aged 16 or older who reside outside the prefecture. Residents aged 16 or older who reside within the prefecture can receive the Comprehensive Health Checkup by any of the following three methods:

1. Receive a Specific Health Checkup or a General Health Checkup conducted by a municipality, wherein the items specific to the Comprehensive Health Checkup are additionally checked
2. Receive a Group Health Checkup conducted by Fukushima Medical University
3. Individually receive the Comprehensive Health Checkup at any of the designated medical institutions in the prefecture



Prepared based on the website of the Radiation Medical Science Center for the Fukushima Health Management Survey, Fukushima Medical University, "Information on the Comprehensive Health Checkup"

Children aged 15 or younger, whether residing in or outside Fukushima Prefecture, can receive the Comprehensive Health Checkup at any of the designated medical institutions with cooperating pediatricians. Examinees should return to the same medical institution respectively to receive explanations on the results directly from doctors. They can consult with doctors and receive answers or treatment on these occasions if they have any worries or if the health checkup results contain some worrisome points.

Residents aged 16 or older who reside in the prefecture can select one of three methods to receive a checkup: Receive a Specific Health Checkup or a General Health Checkup conducted by a municipality, with additional check items specific to the Comprehensive Health Checkup; Receive a Group Health Checkup conducted by Fukushima Medical University; or Receive the Comprehensive Health Checkup individually at a designated medical institution in the prefecture.

Included in this reference material on March 31, 2013

Updated on March 31, 2016

## ■ Changes over year of the results for major check items

(Age bracket: FY2010 - Aged 40 or older; FY2011 to FY2015 - Aged 40 to 64)

Time of the health checkup	Overweight BMI: 25 (kg/m <sup>2</sup> ) or over		Poor glycemic control HbA1c (NGSP): 7.0% or over	
	Male	Female	Male	Female
FY2010 <sup>*1</sup>	29.8%	28.1%	2.4% <sup>*2</sup>	1.6% <sup>*2</sup>
FY2011	41.6%	28.4%	5.7%	2.6%
FY2012	40.3%	29.2%	5.1%	2.4%
FY2013	40.9%	28.9%	5.4%	2.7%
FY2014	39.3%	27.9%	5.1%	2.3%
FY2015	40.6%	28.4%	4.9%	2.4%

Time of the health checkup	Liver function abnormality ALT: 51 (U/L) or over		High blood pressure Systolic blood pressure: 140 mmHg or over	
	Male	Female	Male	Female
FY2010 <sup>*1</sup>	3.8%	1.7%	33.2%	28.7%
FY2011	11.3%	3.9%	27.5%	19.1%
FY2012	11.6%	4.2%	21.5%	14.9%
FY2013	11.2%	3.9%	19.0%	12.9%
FY2014	10.2%	3.5%	17.4%	11.5%
FY2015	10.8%	3.4%	17.4%	12.3%

\*1: The results for FY2010 are those of the Specific Health Checkup and the Older Senior Citizen Health Checkup conducted in FY2010 by municipalities that were later designated as Evacuation Areas, etc. after the earthquake. They are only for reference in the comparison as they differ from the Comprehensive Health Checkup conducted from FY2011 to FY2015 in terms of the cohort and examinees' age brackets.

\*2: HbA1c (JDS)

Prepared based on Handout 3 of the 12th, Handout 3 of the 21st and Handout 3 of the 26th Prefectural Oversight Committee Meetings for Fukushima Health Management Survey

The Comprehensive Health Checkup conducted from FY2011 to FY2015 covered residents of Evacuation Areas designated as of FY2011 and residents who were found to require the Comprehensive Health Checkup as a result of the Basic Survey. The table above shows only the results for the examinees aged 40 to 64. On the other hand, the results for FY2010 are those of the checkup conducted in FY2010, targeting people covered by the national health insurance program aged 40 or older and senior citizens, by municipalities that were later designated as Evacuation Areas, etc. after the earthquake. As these checkups differ from the Comprehensive Health Checkup conducted from FY2011 to FY2015 in terms of the cohort and examinees' age brackets, the results for FY2010 as shown in the table are just for reference.

The condition of being overweight (BMI: 25 kg/m<sup>2</sup> or over) was found more among males than among females. The percentage of examinees who were overweight remained almost unchanged from FY2011 to FY2013 and showed a declining trend from FY2013 to FY2014, but increased again in FY2015 for both males and females.

The percentage of examinees with poor glycemic control (HbA1c: 7.0% or over) decreased in FY2015 from FY2011.

The percentage of examinees with liver function abnormality (ALT: 51 (U/L) or over), which is generally higher among males than among females, has shown no significant changes since FY2011.

The percentage of examinees with high blood pressure (systolic blood pressure: 140 mmHg or over) was higher among males than among females for all age brackets, but the percentage generally has shown a declining trend in FY2012 to FY2015 compared to the level in FY2011.

Included in this reference material on March 31, 2016

Updated on December 1, 2017

## Health Checkup Targeting Residents Uncovered by Existing Health Checkups

### [Outline]

In order to promote the prevention and early detection and treatment of lifestyle-related diseases throughout a lifetime, Fukushima Prefecture now offers a health checkup for residents who have not been covered by the existing systems and have not received health examinations or checkups.

### [Coverage]

Residents aged approximately 19 to 39 who are residing anywhere outside the Evacuation Areas, etc. and have no opportunity to receive health examinations or checkups under the existing systems (i.e., those covered by the national health insurance program and dependents of those covered by the social insurance program, etc., excluding students)

### [Check items]

Body height, weight, BMI, blood pressure, urine test (uric protein and uric sugar), blood biochemistry (AST, ALT,  $\gamma$ -GT, TG, HDL-C, LDL-C, HbA1c, and fasting (or non-fasting) blood sugar)

Prepared based on the material for the 22nd Prefectural Oversight Committee Meeting for Fukushima Health Management Survey

This is the system newly established as part of the Fukushima Health Management Survey for the purpose of offering a health checkup to residents who have not been covered by the existing systems and have not received health examinations or checkups, thereby promoting and maintaining good health and the possibility of healthy longevity for residents of Fukushima Prefecture.

\*1 Health examinations and checkups under the existing systems:

- Health examinations based on the Industrial Safety and Health Act (periodic health examinations, etc.)
- Health checkups for students based on Article 13 of the School Health and Safety Act
- The Comprehensive Health Checkup conducted by Fukushima Prefecture, targeting residents of the Evacuation Areas, etc. (\*2), under the framework of the Fukushima Health Management Survey (the Comprehensive Health Checkup with additional check items)

\* 2 Evacuation Areas, etc.:

The entire areas of Tamura City, Minamisoma City, Kawamata Town, Hirono Town, Naraha Town, Tomioka Town, Kawauchi Village, Okuma Town, Futaba Town, Namie Town, Katsurao Village and Iitate Village, and parts of Date City (the areas containing Specific Spots Recommended for Evacuation)

Included in this reference material on March 31, 2016

Updated on March 31, 2017



**"We will promote the mental and physical health of residents of the Evacuation Areas, etc."**

Fukushima Prefecture has been conducting the Mental Health and Lifestyle Survey with the aim of accurately ascertaining the mental and physical problems of residents who have been facing difficulties due to the Great East Japan Earthquake and the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS in order to provide them with proper health, medical and welfare services, and also handing down to future generations accumulated knowledge on better mental care in an emergency or in the event of a natural disaster.

Prepared based on the website of the Radiation Medical Science Center for the Fukushima Health Management Survey, Fukushima Medical University, "Information on the Mental Health and Lifestyle Survey"

Many of the residents whose houses are located in municipalities designated as Evacuation Areas were forced to evacuate and live as refugees for a prolonged period of time. They have experienced drastic changes in their living environment and must have been forced to change their individual lifestyles as well. In order to carefully watch not only the physical disorders but also mental problems of these residents and offer them appropriate support and build a better system, Fukushima Prefecture has been conducting the Mental Health and Lifestyle Survey.

Included in this reference material on March 31, 2013

Updated on March 31, 2016

**[Coverage]**

Residents who were registered at any of the municipalities designated as Restricted Areas, Deliberate Evacuation Areas or Evacuation-Prepared Areas in Case of Emergency or at any of the areas containing Specific Spots Recommended for Evacuation as of 2011 (approx. 210,000 people) and residents who were found to require the Comprehensive Health Checkup as a result of the Basic Survey

(= The entire areas of Tamura City, Minamisoma City, Kawamata Town, Hirono Town, Naraha Town, Tomioka Town, Kawauchi Village, Okuma Town, Futaba Town, Namie Town, Katsurao Village and Iitate Village, and parts of Date City)

**[Method]**

Prepare inquiry sheets by age bracket (self-reporting questionnaires or those to be filled in by guardians) and send them to the survey targets (responses are received by post or online)

**[Major survey items]**

- Present physical and mental status
- Lifestyle (diet, sleep, and smoking, drinking and exercise habits)
- Present living conditions (the public)

**[Measures after receiving responses]**

For respondents who are deemed to require support based on their responses, clinical psychotherapists, public health nurses, or clinical nurses, etc. of the Mental Health Support Team make a phone call to give advice and support concerning problems with their mental health and lifestyles.

Prepared based on the website of the Radiation Medical Science Center for the Fukushima Health Management Survey, Fukushima Medical University, "Information on the Mental Health and Lifestyle Survey"

As in the case of the Comprehensive Health Checkup, the Mental Health and Lifestyle Survey also covers residents who were registered, as of March 11, 2011, and as of April 1 of the relevant survey year, at any of the municipalities that were designated as Restricted Areas, Deliberate Evacuation Areas or Evacuation-Prepared Areas in Case of Emergency or at any of the areas containing Specific Spots Recommended for Evacuation\* at the time of the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS.

These residents are to respond to questions in an inquiry sheet concerning their mental and physical health conditions. Their responses are compiled into indicators to check their need for support.

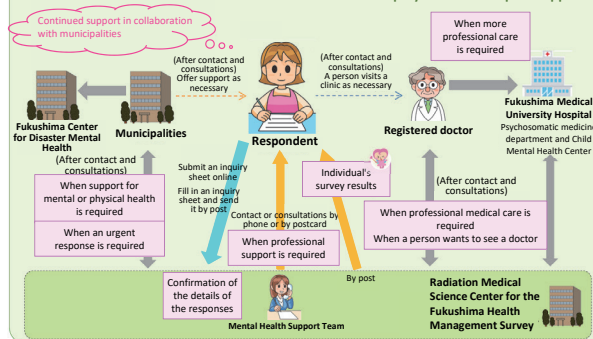
Different inquiry sheets are prepared depending on the age brackets, with the aim of taking required measures more appropriately. Children are divided into four age brackets: those aged zero to 3; those aged 4 to 6; elementary school students; and junior high school students. People aged 16 or older are categorized as the general public.

In addition to questions concerning present mental and physical health conditions, the survey items include questions about changes in lifestyles, such as diet, sleep, drinking, smoking, and exercise habits, as respondents must have experienced drastic changes in their living environment.

Included in this reference material on March 31, 2013

Updated on December 1, 2017

Relevant organizations and doctors are collaboratively offering care.  
- Procedures from submission of an inquiry sheet to receipt of support -



\* For people who are deemed to require continued support, care is provided on an ongoing basis through collaboration among regional registered doctors, municipalities and the Fukushima Center for Disaster Mental Health.

\* Survey results are sent individually from FY2014.

[Registered doctors] Psychiatrists and pediatricians, etc., who have received lectures concerning disaster mental health and radiation medical science: As of the end of December 2017, there are 130 registered doctors in 81 medical institutions.

	Number of people who received support by phone		Number of people who received support in writing	
	Children	People aged 16 or older	Children	People aged 16 or older
FY2011	1,180	6,310	1,066	10,898
FY2012	623	5,991	800	10,168
FY2013	473	3,913	752	7,664
FY2014	327	3,053	517	6,244
FY2015	250	2,567	435	6,075

Prepared based on the materials for the 11th, 15th, 19th, 22nd, 26th and 27th Prefectural Oversight Committee Meetings for Fukushima Health Management Survey

Analysis results are individually sent to people who have submitted inquiry sheets.

For respondents who are considered to require professional support as a result of analyzing their responses, clinical psychotherapists, public health nurses, or clinical nurses, etc. make a phone call to give advice and support concerning problems with their mental health and lifestyles. For people who did not enter their telephone numbers in inquiry sheets, contact is made in writing.

Remarks by people who have received support by phone include, "I am glad that I can confess what I cannot say to my family," or, "I am relieved to know that I can call this number to make consultations whenever I feel depressed."

Regarding those in need of continued support or professional medical care, relevant information is shared among municipalities, the Fukushima Center for Disaster Mental Health and registered doctors, on a case-by-case basis, to create a more positive support network.

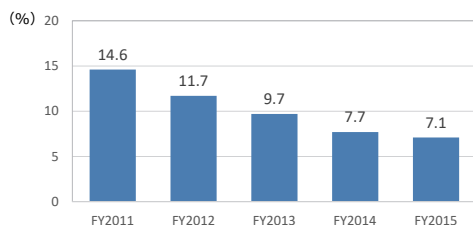
Included in this reference material on March 31, 2013

Updated on December 28, 2017

## Mental Health and Lifestyle Survey: What Has Become Clear (1/4)

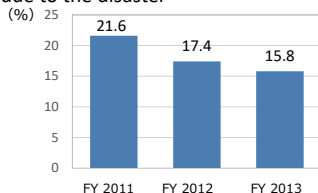
Latest Survey Results: <http://www.pref.fukushima.lg.jp/site/portal/kenkocycosa-kentoiinkai.html> (in Japanese)

- Percentage of people who are considered to require support for their depressions and anxieties

Measurement scale: **K6\***

\* Respondents reply to each question of a six-item questionnaire concerning their depression and anxieties with a score from zero to four points. When the total is 13 points or over, a mood disorder or anxiety disorder is suspected.

- Percentage of people who are considered to require support for their traumatic stresses due to the disaster

Measurement scale: **PCL\***

\* Respondents reply to each question of a 17-item questionnaire concerning their frequently arising problems and need arising from their disaster experience (traumatic stress) with a score from zero to five. When the total is 44 points or over, PTSD is suspected.

\*In order to ease psychological burdens associated with replying to the questionnaire, the FY2014 and FY2015 surveys did not include PCL-related questions.

Prepared based on the materials for the 11th, 15th, 19th and 23rd and 27th Prefectural Oversight Committee Meetings for Fukushima Health Management Survey

- K6\*1 remains at a high level, although the values have been declining compared with the FY2011 survey and the FY2012 survey.
- Females show higher values than males. The gap by age bracket was the smallest in FY2015 compared with the results of the past surveys.
- PCL\*2 remains at a high level, although the values have been declining compared with the FY2011 survey and the FY2012 survey.

\*1: K6 = Scale to measure the levels of depression and anxieties

Respondents reply to each question of a six-item questionnaire concerning the frequencies with which they felt depressed or anxious during the past 30 days (such as "Have you felt extremely nervous?" or "Have you felt desperate and helpless?"). This survey targets people aged 16 or older to ascertain whether any mood or anxiety disorder poses a problem in their daily lives, based on their responses.

\*2: PCL (Post-Traumatic Stress Disorder Checklist) = Scale to measure traumatic stresses

Respondents reply to each question of a 17-item questionnaire concerning how often they had problems and needs arising from their disaster experience (traumatic stress) during the past 30 days (such as "Repeatedly remembered disturbing memories, ideas, images (scenes) of the relevant stress experience" or "Repeatedly had disturbing dreams of the relevant stress experience"). Through this survey, individuals' levels of traumatic stress are ascertained.

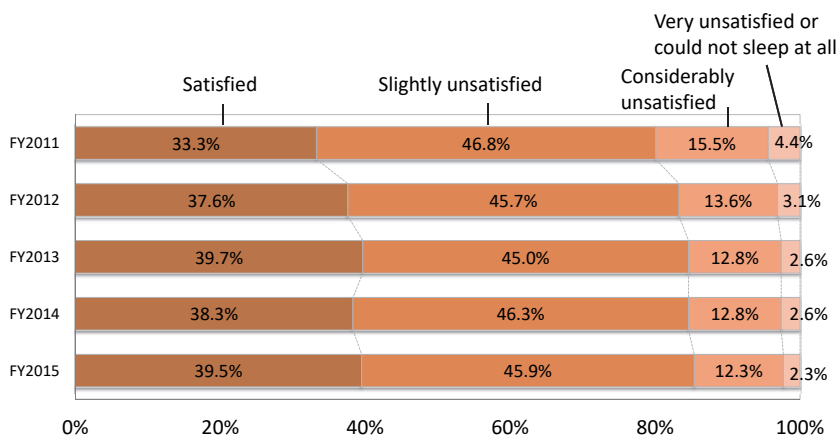
Included in this reference material on March 31, 2015

Updated on December 1, 2017

## Mental Health and Lifestyle Survey: What Has Become Clear (2/4)

Latest Survey Results: <http://www.pref.fukushima.lg.jp/site/portal/kenkocyoa-kentoiinkai.html> (in Japanese)

[Levels of satisfaction regarding sleep during the latest one month period] Those aged 16 or older



Prepared based on the materials for the 11th, 15th, 19th, 23rd and 27th Prefectural Oversight Committee Meetings for Fukushima Health Management Survey

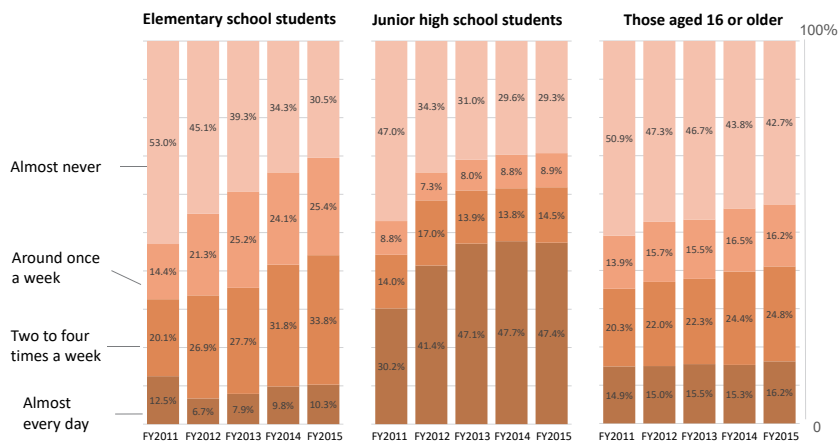
Sleep is a significant factor that exerts influence on various chronic diseases such as high blood pressure or diabetes, as well as affecting people's mental health.

It should be noted that approximately 60% of the respondents are somewhat unsatisfied with their sleep to some degree.

Included in this reference material on March 31, 2016

Updated on December 1, 2017

[Percentages concerning daily exercises]



Prepared based on the materials for the 11th, 15th, 19th, 23rd and 27th Prefectural Oversight Committee Meetings for Fukushima Health Management Survey

Not only those aged 16 or older, but also elementary school students and junior high school students have come to have more chances for exercises, showing an improving trend.

In particular, exercises are considered to exert a significant influence on the growth of elementary school students and junior high school students.

Included in this reference material on March 31, 2016

Updated on December 1, 2017

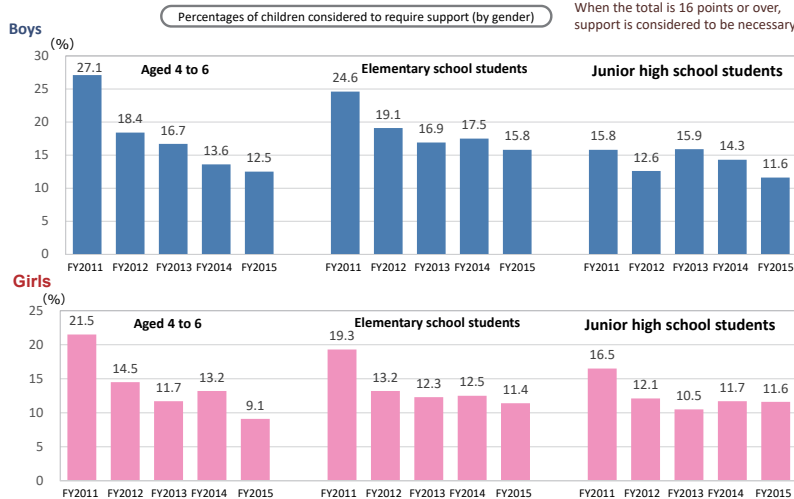
## Mental Health and Lifestyle Survey: What Has Become Clear (4/4)

Latest Survey Results: <http://www.pref.fukushima.lg.jp/site/portal/kenkocysa-kentoinkai.html> (in Japanese)

[Children's mental health conditions]

Measurement scale: SDQ\*

When the total is 16 points or over, support is considered to be necessary.



Prepared based on the materials for the 11th, 15th, 19th, 23rd and 27th Prefectural Oversight Committee Meetings for Fukushima Health Management Survey

- As an indicator to evaluate children's mental health conditions, SDQ\* is utilized.
- In a prior study targeting the public in Japan who did not experience the nuclear disaster, people showing SDQ points over 16 accounted for 9.5% of the total. Compared with this, percentages of children showing SDQ points over 16 were higher for all groups except for girls aged 4 to 6 in the FY2015 survey, as was the case in the surveys in previous fiscal years.
- In the FY2015 survey, percentages of high SDQ points decreased for all groups compared with the results of the FY2011 survey. However, the improvement slowed down and the percentages remained almost unchanged from those of the FY2012 survey.
- Hours of sleep in the FY2015 survey were almost the same as those in the FY2012 survey and were approaching the level shown in the preceding study. Furthermore, the FY2015 survey shows a declining trend in percentages of children who seldom do exercise, but suggests poorer exercise habits compared with the results of a nationwide survey, although a direct comparison is difficult due to differences in survey content.

\* SDQ (Strengths and Difficulties Questionnaire) = Scale to measure children's mental health conditions

Respondents reply to each question of a 25-item questionnaire concerning children's moods and behavior during the past six months (such as "Gives due consideration to other's feelings" or "Is restless and cannot stay still for a long time"). This survey covers those aged 4 to 15 to judge whether they need professional support or not.

Included in this reference material on March 31, 2015

Updated on December 1, 2017

### **"We will promote the health of pregnant women in Fukushima Prefecture."**

Many pregnant women intending to give birth and raise children in Fukushima Prefecture have been forced to live as refugees due to the Great East Japan Earthquake and the accident at Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi NPS, and have stresses from changes in their lifestyles and worries concerning radiation.

Therefore, Fukushima Prefecture has been conducting the Pregnancy and Birth Survey with the aim of properly ascertaining those pregnant women's current status, mental and physical health conditions, as well as opinions and wishes in order to alleviate their worries, provide necessary care and ensure peace of mind and, to utilize the obtained data for improving obstetric and perinatal care in Fukushima Prefecture.

Prepared based on the material for the 22nd Prefectural Oversight Committee Meeting for Fukushima Health Management Survey

Worries, anxieties and stresses caused by the accident at TEPCO's Fukushima Daiichi NPS have been obstacles for women who intend to give birth and raise children in Fukushima Prefecture.

In light of such circumstances, Fukushima Prefecture has been conducting the Pregnancy and Birth Survey in order to ascertain pregnant women's mental and physical health conditions with the aim of providing care to those considered to be in need of support such as an opportunity to have consultations with midwives or public health nurses. At the same time, the survey also aims to obtain data to be utilized for improving obstetric and perinatal care in Fukushima Prefecture.

Included in this reference material on March 31, 2013

Updated on March 31, 2016



## Pregnancy and Birth Survey: Outline (1/2)

### [Coverage]

Pregnant women who obtained a maternity handbook within Fukushima Prefecture and those who obtained a maternity handbook somewhere else but gave birth in the prefecture during the survey period for every fiscal year

Fiscal year	Coverage	Responses from	
FY2011	16,001 people	9,316 people (58.2%)	Conducted a follow-up survey in approx. 4 years after delivery
FY2012	14,516 people	7,181 people (49.5%)	
FY2013	15,218 people	7,260 people (47.7%)	
FY2014	15,125 people	7,132 people (47.2%)	
FY2015	14,569 people	6,866 people (47.1%)	
FY2016*	14,138 people	6,069 people (42.9%)	
			Coverage Responses from
			7,252 people 2,554 people (35.2%)
			5,602 people 2,021 people (36.1%)

\* Provisional values (as of April 30, 2017)

### [Survey method]

Inquiry sheets are sent to the targeted pregnant women, asking them to fill in the sheets and send them back.

(From the FY2016 survey, responses are accepted by post or online.)

Major survey items are as follows:

- Pregnant women's mental health conditions
- Present living conditions (circumstances of a refugee life or forced separation from family members)
- Situations during delivery and pregnant women's physical health conditions
- Confidence in raising children
- Attitude toward the next pregnancy

Prepared based on the website of the Radiation Medical Science Center for the Fukushima Health Management Survey, Fukushima Medical University and the materials for the 27th and 28th Prefectural Oversight Committee Meetings for Fukushima Health Management Survey

The Pregnancy and Birth Survey covers pregnant women who newly obtained a maternity handbook every fiscal year.

Not only those who obtained a maternity handbook in Fukushima Prefecture but also those who obtained a maternity handbook somewhere else but gave birth in the prefecture are covered.

For the former, inquiry sheets are sent based on information provided by each municipality in the prefecture. The latter may use inquiry sheets available at obstetric institutions in the prefecture or ask the Radiation Medical Science Center for the Fukushima Health Management Survey to send them inquiry sheets.

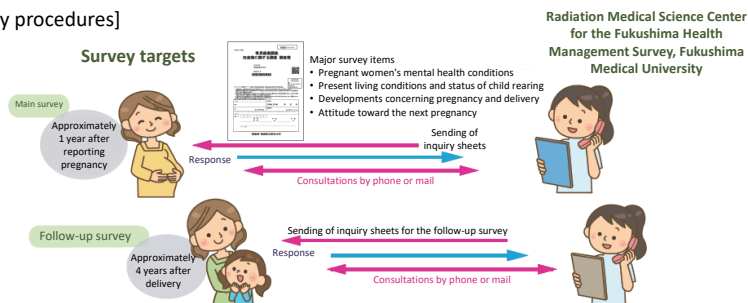
Survey targets are asked to fill in inquiry sheets and send them back. From the FY2016 survey, responses can also be submitted online.

Included in this reference material on March 31, 2013

Updated on December 1, 2017

## Pregnancy and Birth Survey: Outline (2/2)

### [Survey procedures]



- Coverage of the FY2017 main survey
  - (i) Pregnant women who obtained a maternity handbook in any municipality in Fukushima Prefecture from August 1, 2016, to July 31, 2017
  - (ii) Pregnant women who obtained a maternity handbook outside Fukushima Prefecture during the period mentioned above but gave birth in Fukushima Prefecture
- Coverage of the FY2017 follow-up survey
 

Respondents of the FY2013 survey who gave birth from August 1, 2012, to April 8, 2014

→ Since the FY2016 survey, responses can also be submitted online.

**On the website of the Radiation Medical Science Center for the Fukushima Health Management Survey, responses can be made using personal computers or smartphones.**

Prepared based on the leaflet on the Pregnancy and Birth Survey, and the website of the Radiation Medical Science Center for the Fukushima Health Management Survey, Fukushima Medical University

Details of the responses are compiled by the Radiation Medical Science Center for the Fukushima Health Management Survey to detect people considered to be in need of support. \* If there are any people who are considered to be in need of support, midwives, public health nurses, doctors or other specialized staff members offer consultations or other support to such people by mail or by other means.

\* Respondents who replied that they tend to feel depressed and that they are not interested in things, or respondents who are considered to be in need of support based on the content of their free remarks (such as those who are in need of help, who are severely depressed, who need support for child rearing, who are worried about radiation doses, or who directly made requests or are requiring concrete answers)

Included in this reference material on March 31, 2013

Updated on December 1, 2017

## Pregnancy and Birth Survey: Achievement and Content of Support

### [Changes in coverage]

Out of all respondents, for those who were judged to be in need of support from the content of their responses, support has been offered by full-time midwives, etc. by phone or mail.

Fiscal year	Number of people who received support by phone	Percentage of those who received support among all respondents		Number of people who received support by phone	Percentage of those who received support among all respondents
FY2011	1,401 people	15.0%	Survey following up the FY2011 survey	375 people	14.7 %
FY2012	1,104 people	15.4%	Survey following up the FY2011 survey	255 people	12.7 %
FY2013	1,101 people	15.2%			
FY2014	830 people	11.6%			
FY2015	913 people	13.0%			
FY2016*	782 people	12.9%			

\* Provisional values (as of April 30, 2017)

### [Topics of the consultations by phone]

	FY2011	FY2012	FY2013	FY2014 to FY2015 (the same ranking for both years)	Survey following up the FY2011 survey
1st	Worries over radiation and its effects	Mothers' mental and physical health	Mothers' mental and physical health	Mothers' mental and physical health	Mothers' mental and physical health
2nd	Mothers' mental and physical health	Matters concerning child rearing	Matters concerning child rearing	Matters concerning child rearing	Worries over radiation and its effects
3rd	Matters concerning child rearing	Worries over radiation and its effects	Children's mental and physical health	Matters concerning family life	Matters concerning child rearing

Matters concerning child rearing include concerns about baby food, night crying, constipation, vaccination, etc.

Prepared based on the material for the 27th Prefectural Oversight Committee Meeting for Fukushima Health Management Survey

Immediately after the earthquake, the most frequent topic was worries over radiation and its effects, but the percentage of such consultations is declining over time. Since FY2012, consultations on mothers' mental and physical health and matters concerning child rearing have increased and now rank high.

Regarding the survey following up the FY2012 survey, those who required support accounted for 12.7% of all respondents, showing a decrease from the percentage at the time of the survey following up on the FY2011 survey (14.7%). The most frequent topic was mothers' mental and physical health (44.9%). Consultations concerning worries over radiation and its effects accounted for 13.3%, considerably lower than at the time of the survey following up on the FY2011 survey (25.6%).

Included in this reference material on March 31, 2013

Updated on December 1, 2017

## [Percentages of premature births, low birth-weight babies, and congenital abnormalities or anomalies]

Percentages of premature births, low birth-weight babies, and congenital abnormalities or anomalies obtained through the Pregnancy and Birth Survey were almost the same as the general level and those obtained through nationwide surveys.

(%)

	Percentage of premature births		Percentage of low birth-weight babies		Percentage of congenital abnormalities or anomalies	
	Main survey	Nationwide survey	Main survey	Nationwide survey	Main survey	General level
FY2011	4.8	5.7	8.9	9.6	2.85	3 to 5 (based on the 2014 Obstetric Care Guidelines)
FY2012	5.7	5.7	9.6	9.6	2.39	
FY2013	5.4	5.8	9.9	9.6	2.35	
FY2014	5.4	5.7	10.1	9.5	2.30	
FY2015	5.8	5.6	9.8	9.5	2.24	

Nationwide surveys: Percentages based on the Vital Statistics    Premature births: Babies born at a gestational age from 22 weeks to less than 37 weeks  
Low birth-weight babies: Babies born smaller than 2500g

Prepared based on the material for the 26th Prefectural Oversight Committee Meeting for Fukushima Health Management Survey

The number of babies born in Fukushima Prefecture decreased temporarily after the earthquake, but the number increased in FY2013 and FY2014 compared with FY2012.

Radiation effects on newborn babies had been worried about, but percentages of premature births, low birth-weight babies, and congenital abnormalities or anomalies in Fukushima Prefecture after the earthquake were found to be almost the same as generally available data, including Vital Statistics collected nationally.

A report of a FY2013 Ministry of Health, Labour and Welfare (MHLW) Grant Research, "Research on the Incidence of Congenital Anomalies in Japan and Effect Factors (Including Effects of Radiation Exposure and Prenatal Diagnoses) through Monitoring Analysis," states that the incidence of congenital anomalies detected among 17,773 babies born at 36 maternity hospitals in Fukushima Prefecture after the earthquake shows similar outcomes to nationwide surveys, with no notably higher outlying events when compared with other prefectures.

Included in this reference material on March 31, 2015

Updated on December 1, 2017

## Pregnancy and Birth Survey: What Has Become Clear (2/2)

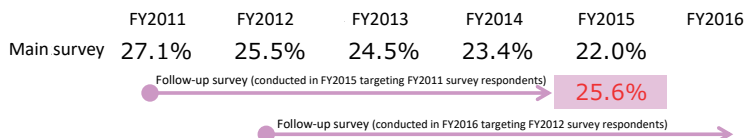
Latest Survey Results: <http://www.pref.fukushima.lg.jp/site/portal/kenkocyosa-kentoiinkai.html> (in Japanese)

## [Changes in pregnant women's depressive tendencies]

The percentage of respondents who replied that they tend to feel depressed and/or that they are not interested in things



Pregnant women's depressive tendencies have been weakening gradually but are still strong.



## [Changes in percentage of respondents who answered "Yes" to the question "Are you considering another pregnancy?"]

Nationwide survey	Pregnancy and Birth Survey					
	FY2010	FY2012	FY2013	FY2014	FY2015	FY2016*
	51.0%	52.9%	52.8%	57.1%	53.3%	55.4%

Percentage of respondents who are married for less than 10 years and plan to have a child in the nationwide survey, "Fourteenth Japanese National Fertility Survey in 2010" (when having any children already)

\* The 2011 survey did not contain the relevant question.

\* Provisional values (as of March 31, 2017)

Prepared based on the material for the 27th Prefectural Oversight Committee Meeting for Fukushima Health Management Survey

For questions concerning pregnant women's depressive tendencies, respondents who replied that they tend to feel depressed and/or that they are not interested in things have been decreasing but such tendencies are still strong.

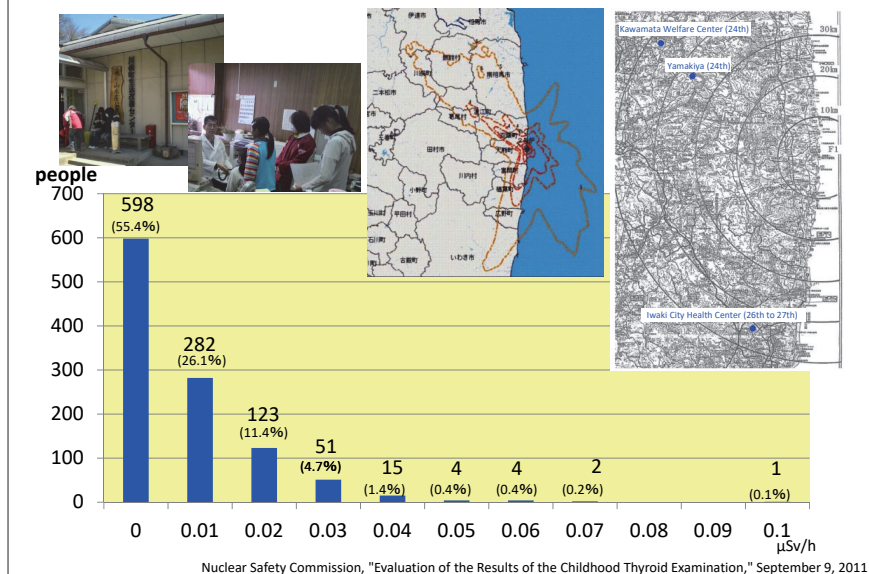
According to the "Healthy Parents and Children 21" (a national campaign to promote improvement of health standards of mothers and children), the percentage of postnatal depression evaluated using the Edinburgh Postnatal Depression Scale was 9.0% in 2013. On the other hand, that percentage using the same scale and calculated from the results of the FY2016 Pregnancy and Birth Survey (provisional values) was 11.2%, higher than the national average.

The FY2016 Pregnancy and Birth Survey (provisional values) also revealed that respondents considering another pregnancy accounted for 53.3%. Since the FY2012 survey, more than half of the respondents wish to have more children. For reference, according to the Fourteenth Japanese National Fertility Survey in 2010, respondents who are married for less than ten years and plan to have a child accounted for 58% (or 51% among those who already have any children).

Included in this reference material on March 31, 2015

Updated on December 1, 2017

# Childhood Thyroid Examination



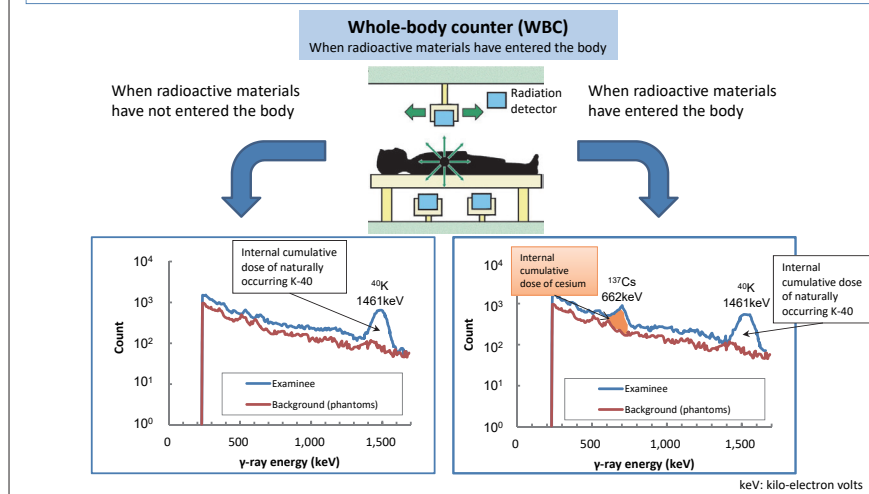
Based on estimates by SPEEDI on March 23, 2011, the Local Nuclear Emergency Response Headquarters conducted the Childhood Thyroid Examination to ascertain health effects of radiation on children in response to a request from the Technical Advisory Organization in an Emergency of the Nuclear Safety Commission of Japan (dated March 23 and 25). The figure shows the results for 1,080 children for whom measurement was conducted properly, out of 1,149 survey targets. The figure excludes the results for 66 children for whom simplified measurement was not appropriate due to environmental doses at their measuring spots (proper evaluation based on simplified measurement was difficult due to high ambient dose rates) and for three children whose ages were unknown. However, for all children who received the examination, measured values were below 0.2  $\mu\text{Sv/h}$ , which is set as the standard screening level by the Nuclear Safety Commission of Japan.

Included in this reference material on March 31, 2013

Updated on March 31, 2017

# Internal Exposure Measurement Using a Whole-body Counter

**Whole-body counter (WBC):** A device to measure radiation from radioactive materials within the body. It can measure radionuclides emitting  $\gamma$ -rays, such as Cs-134 and Cs-137.



A whole-body counter is a device to measure  $\gamma$ -rays emitted from the body. As  $\gamma$ -ray energy differs by radionuclide, if a specific amount of energy, for example, 1,461 keV, which is the  $\gamma$ -ray energy of radioactive potassium (K-40), is counted, this can be interpreted as  $\gamma$ -rays emitted from K-40 in the body. The  $\gamma$ -ray energy of Cs-137 is 662 keV.

Potassium is an essential element for a living organism and approximately 0.01% of it is radioactive. Radioactive potassium is mainly dissolved in cellular water and exists in muscles but not so much in fat cells that contain little water.

As radioactive cesium spreads all over the body, the internal dose of cesium is measured using a whole-body counter.

Included in this reference material on March 31, 2013

Updated on March 31, 2016

## Results of the Internal Exposure Measurement Using a Whole-body Counter

Targeting the residents of the Evacuation Areas and the areas where internal and external exposure doses are likely to be higher than in other areas based on the results of the environmental monitoring survey, etc. (Yamakiya District in Kawamata Town, Iitate Village and Namie Town), the internal exposure measurement using a whole-body counter commenced on June 27, 2011. The targeted areas were expanded sequentially, and measurements were conducted for a total of 328,354 people by November 30, 2017. For over 99.9% of them, committed effective doses due to Cs-134 and Cs-137 were below 1 mSv and even the maximum measured value was below 3 mSv. Measured values were all unlikely to cause any health effects.

- (i) Targeted local governments: All 59 municipalities in Fukushima Prefecture
- (ii) Organizations that conducted the measurement  
Fukushima Prefecture; Hirosaki University Hospital; Minamisoma City General Hospital; Japan Atomic Energy Agency; Niigata Prefecture Radiation Examination Office; Hiroshima University Hospital; Nagasaki University Hospital; Japanese Red Cross Otsu Hospital; Mori no Miyako Industrial Health Association; National Hospital Organization Kanazawa Medical Center; Ehime University Hospital; and the National Institute of Radiological Sciences
- (iii) 'Mobile measurement' using whole-body counter vehicles outside Fukushima Prefecture  
Fukushima Prefecture runs whole-body counter vehicles for mobile measurement so that evacuees outside the prefecture can also receive measurement. By March 2016, mobile measurement was conducted in 38 prefectures including the Tokyo Metropolis (other than Aomori, Ibaraki, Niigata, Ishikawa, Shiga, Hiroshima, Aichi and Nagasaki Prefectures), where there is no permanent organization to which Fukushima Prefecture commissions the measurement.
- (iv) Measurement results (committed effective doses) (Results up to November 2017 were released on December 26, 2017).

	Jun. 27, 2011 – Jan. 31, 2012	Feb. 1, 2012 – Nov. 30, 2017	Total
Less than 1 mSv	15,384 people	312,944 people	328,328 people
1 mSv	13 people	1 person	14 people
2 mSv	10 people	zero	10 people
3 mSv	2 people	zero	2 people
Total	15,409 people	312,945 people	328,354 people

\* Committed effective dose: Assuming that until the end of January 2012, a person ingested radiation once on March 12, 2011, and, from February 2012 onward, a person orally ingested the equal amount of radiation every day from March 12, 2011, to the day preceding the measurement date, the person's lifetime internal doses are calculated by summing up the doses for fifty years in the case of an adult and for the years elapsed until becoming 70 years old in the case of a child.

Prepared based on the website of Fukushima Prefecture, "Results of the Internal Exposure Measurement Using a Whole-body Counter"

Targeting the residents of the Evacuation Areas and the areas where internal and external exposure doses are likely to be higher than in other areas based on the results of the environmental monitoring survey, etc. (Yamakiya District in Kawamata Town, Iitate Village and Namie Town), the internal exposure measurement using a whole-body counter commenced on June 27, 2011. The targeted areas were expanded sequentially, and the measurements were conducted for a total of 328,354 people by November 30, 2017. For over 99.9% of them, committed effective doses due to Cs-134 and Cs-137 were below 1 mSv and even the maximum measured value was below 3 mSv. Measured values were all unlikely to cause any health effects.

Included in this reference material on March 31, 2013

Updated on December 31, 2017



## Internal Exposure due to Foods

- Radioactive cesium is eliminated from the body over time.
- The internal exposure measurement using a whole-body counter being conducted at present examines the effects of radiation that is ingested orally on a daily basis.
- Measured values exceeding 1 mSv are considered to be mostly caused by radiation **derived from wild plants or animals**. Since March 2012, values exceeding 1 mSv have not been detected.

\* Reference: p.73 of Vol. 2, "Mushrooms, Mountain Vegetables and Wild Bird and Animal Meat"

- Q. What if the measurement using a whole-body counter detected any value exceeding the detection limit?
- A. The relevant person may have eaten a lot of foods – not allowed in commercial markets – that contain radioactive cesium at high concentrations, e.g., wild mushrooms, wild plants, wild bird and animal meat (wild boars, bears, etc.).

Prepared based on the following:

Masaharu Tsubokura, et.al. "Reduction of High Levels of Internal Radio-Contamination by Dietary Intervention in Residents of Areas Affected by the Fukushima Daiichi Nuclear Plant Disaster: A Case Series," PLoS One. 2014; 9(6): e100302., US National Library of Medicine, National Institutes of Health, Published online 2014 Jun 16

As radioactive cesium is eliminated from the body over time, the radioactive cesium that people ingested immediately after the earthquake has mostly been eliminated.

The internal exposure measurement using a whole-body counter being conducted at present examines the effects of radiation that is ingested orally on a daily basis. Measured values exceeding 1 mSv per year are considered to be mostly caused by radiation derived from wild plants and animals. As long as people eat only foods distributed through regulated commercial marketplaces, their annual internal doses will not exceed 1 mSv. If the annual internal dose exceeds 1 mSv, the relevant person may have eaten a lot of foods – not allowed in commercial markets – that contain radioactive cesium at high concentrations. In particular, cases have been reported where wild mushrooms are suspected to cause high internal doses.

Included in this reference material on March 31, 2013

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## Self-Protection against Internal Exposure

- General protection against radioactive cesium  
It is very effective to
  - Have knowledge on foods that contain a high level of radioactive cesium
  - Avoid eating the same food continuously
  - Try to eat a variety of foods produced in diverse areas.
- Current status in Fukushima
  - Continued ingestion of radiation is unlikely except from foods.
  - There is no significant difference whether one selects foods and water produced locally or selects those produced in other areas.
- Obtaining accurate information is extremely important.

Prepared based on the material released by the 9th Opinion Exchanges, Foodservice Industry Research Institute (September 3, 2012)

In order to avoid further internal exposure, it is effective to have knowledge on foods that contain a high level of radioactive cesium, avoid eating same food continuously, and try to eat a variety of foods produced in diverse areas. Obtaining accurate information is extremely important.

Included in this reference material on March 31, 2013

Updated on March 31, 2016

## Abbreviations

Act on Special Measures Concerning Nuclear Emergency	Act on Special Measures Concerning Nuclear Emergency Preparedness
Act on Special Measures (Concerning the Handling of Environment Pollution by Radioactive Materials)	Act on Special Measures Concerning the Handling of Environmental Pollution by Radioactive Materials Discharged by the Nuclear Power Plant Accident Accompanying the Earthquake that Occurred off the Pacific Coast of the Tohoku Region on March 11, 2011
ADI	Acceptable Daily Intake
ALARA	As Low As Reasonably Achievable
ALPS	Advanced Liquid Processing System
BMI	Body Mass Index
BSS	Basic Safety Standards
CT	Computed Tomography
DDREF	Dose and Dose Rate Effectiveness Factor
DNA	Deoxyribonucleic Acid
EEG	Electroencephalogram
EUROCAT	European Surveillance of Congenital Anomalies
GM counter	Geiger-Müller counter
HPCI	High Pressure Coolant Injection System
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
ILO	International Labour Organization
INES	International Nuclear Event Scale
IQ	Intelligence Quotient
IXRPC	International X-ray and Radium Protection Committee
JAEA	Japan Atomic Energy Agency
JESCO	Japan Environmental Storage & Safety Corporation
J-RIME	Japan Network for Research and Information on Medical Exposure
LNT model	Linear Non-Threshold model
MRI	Magnetic Resonance Imaging

MRL	Maximum Residue Levels
NAS	National Academy of Sciences
ND	Not Detected
OECD/NEA	Organisation for Economic Co-operation and Development/Nuclear Energy Agency
PET	Positron Emission Tomography
PFA	Psychological First Aid
PTSD	Posttraumatic Stress Disorder
RCIC	Reactor Core Isolation Cooling System
SDQ	Strengths and Difficulties Questionnaire
SPEEDI	System for Prediction of Environmental Emergency Dose Information
TDI	Tolerable Daily Intake
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
WBC	Whole Body Counter
WHO	World Health Organization

## ■ Units

Sv	Sievert
Bq	Becquerel
Gy	Gray
eV	electron volt
J	Joule

## SI prefixes

Symbol	Reading	Exponential (decimal notation)
T	tera	$10^{12}$ (1 000 000 000 000)
G	giga	$10^9$ (1 000 000 000)
M	mega	$10^6$ (1000 000)
k	kilo	$10^3$ (1 000)
d	deci	$10^{-1}$ (0.1)
c	centi	$10^{-2}$ (0.01)
m	milli	$10^{-3}$ (0.001)
$\mu$	micro	$10^{-6}$ (0.000 001)
n	nano	$10^{-9}$ (0.000 000 001)

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## Glossary

### A

#### Act on Special Measures Concerning the Handling of Environment Pollution by Radioactive Materials

The radioactive materials released due to the accident at TEPCO's Fukushima Daiichi NPS after the Great East Japan Earthquake caused environmental pollution. This Act aims to promptly reduce the influence of this environmental pollution on human health and living environments, and provides for the monitoring and measurement of the environmental pollution, disposal of waste contaminated with radioactive materials, decontamination of soil and other countermeasures. (Based on the website of the Ministry of the Environment)

#### Actinoid

The actinoid (actinide) series encompasses the 15 elements with atomic numbers from 89 to 103, namely Ac, Th, Pa, U, Np, Pu, Am, Cm, Bk, Cf, Es, Fm, Md, No, and Lr. All actinoids are radioactive and release energy upon radioactive decay. Naturally occurring uranium and thorium and artificially produced plutonium are the most abundant actinides on Earth.

#### Additional doses

The term "additional dose" refers to a dose received from radioactive sources that were unintentionally generated. After the TEPCO's Fukushima Daiichi NPS accident, the additional dose often refers to the dose from the artificial radionuclides (e.g., Cesium-137) distinct from the dose from naturally existing radionuclides (e.g., Potassium-40).

#### Ambient dose

An ambient dose refers to the amount of radiation in the air. Gamma rays from radioactive materials on or near the ground surface and gamma rays from radioactive materials in the air affect ambient dose levels.

#### Areas under Evacuation Orders

Areas for which evacuation orders were issued based on Article 15, paragraph (3) of the Act on Special Measures Concerning Nuclear Emergency Preparedness; Areas under Evacuation Orders consisted of Deliberate Evacuation Areas and the 20-km zone of the Nuclear Power Station. The areas were reviewed and were newly organized as Preparation Areas for Lift of Evacuation Order, Habitation Restricted Areas, and Areas where Returning is Difficult.

#### Areas where Returning is Difficult

Areas where annual accumulated doses are currently over 50mSv and are highly likely to be over 20mSv even after five years from the accident at TEPCO's Fukushima Daiichi NPS; Residents who temporarily enter these areas must undergo thorough screening, manage their own individual doses and wear protective gear. (Based on the website of Fukushima Prefecture [d])

#### Artificial radionuclides

Man-made radionuclides produced by a nuclear reactor and an accelerator in contrast to naturally-occurring radionuclides. (Based on the website of the Nuclear Fuel Cycle Engineering Laboratories, JAEA)

### Atmospheric nuclear testing

Nuclear testing conducted on the ground, at sea or in the air; There are also underwater nuclear testing, underground nuclear testing and exoatmospheric nuclear testing. Nuclear testing other than that to be conducted underground was all banned under the Partial Test Ban Treaty (PTBT), which was signed in 1963. (Based on the website of the Research Organization for Information Science and Technology)

## B

### Basic Survey

The Basic Survey is a questionnaire survey targeting roughly 2,050,000 residents of and visitors to Fukushima Prefecture as of March 11, 2011. Estimated external radiation doses were calculated based on recorded movements of respondents in the four months following the nuclear accident. (Based on the website of the Radiation Medical Science Center, Fukushima Medical University)

## C

### Calibration constant

Calibration means to clarify the relationship between a correct value and instrument readings, and such relationship expressed in a ratio is referred to as a calibration constant. When measuring radiation, correct values are to be obtained by multiplying instrument readings by a calibration constant. A calibration constant is generally indicated on a calibration label attached to a radiation meter.

### Cell degeneration

Passing from a state of goodness to a lower state by losing qualities desirable for normal cell function that results in, for example, deformity or malfunctioning.

### Cesium

Cesium (Caesium) is a chemical element with atomic number 55. Cesium-137 ( $^{137}\text{Cs}$ ) and Cesium-134 ( $^{134}\text{Cs}$ ) are radioisotopes of cesium and their physical half-lives are about 30 and two years, respectively.  $^{137}\text{Cs}$  decomposes to  $^{137}\text{Ba}$  through beta decay associated with gamma radiation (0.662 MeV), and then to nonradioactive barium.  $^{137}\text{Cs}$  is generated as one of the fission products, whereas  $^{134}\text{Cs}$  is generated through neutron capture of stable cesium. The biological half-life of cesium is about 70 to 100 days for adults and is shorter for children.  $^{137}\text{Cs}$  and  $^{134}\text{Cs}$  were released into the environment due to the Fukushima Daiichi nuclear power plant accident as well as other radioisotopes such as radioiodine. On the other hand,  $^{137}\text{Cs}$  is commonly used as a gamma emitter in industrial application.

### Chernobyl Nuclear Accident

A nuclear reactor accident that occurred at Unit 4 of the Chernobyl Nuclear Power Plant in the Ukrainian Republic on April 26, 1986

### Chronic exposure

Chronic exposure means continuous or intermittent exposure to radiation over a long period of time. In contrast to acute exposure, tissue reactions caused by exposure are less severe if the total radiation dose is the same.

### Codex Alimentarius Commission

An intergovernmental body created in 1963 by the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) for the purpose of protecting consumers' health and ensuring fair-trade practices in the food trade, etc.; The Commission establishes international standards for foods.

### Cold shut-down

A situation where a fission reaction has been suppressed through the insertion of control rods and the temperature in the reactor is stably maintained at 100°C or lower by continued cooling.

### Committed effective dose

The sum of the products of the committed organ or tissue equivalent doses and the appropriate tissue weighting factors (wT). The commitment period is taken to be 50 years for adults, and to age 70 years for children. (Cited from ICRP, 2007) (See p.53 in Vol. 1 (Chapter 2) for details)

### Committed effective dose coefficient

The coefficient is indicated as a committed effective dose for a person who has ingested or inhaled 1Bq of radioactive materials considering type of radionuclide, intake route (ingestion, inhalation, etc.), and age group (adults, young children, infants). The coefficient differs by age group because time integrated dose is taken into account for a period of 50 years for adults and for a period of becoming up to age 70 for children, and also because biological half-lives and sensitivity differ between adults and children.

$\text{Intake (Bq)} \times (\text{Committed}) \text{ effective dose coefficient (mSv/Bq)} = (\text{Committed}) \text{ effective dose (mSv)}$

(Based on the website of the Food Safety Commission of Japan)

### Committed effective doses per unit intake (Bq)

See "Committed effective dose coefficient".

### Comprehensive Health Checkup

The program aims at early detection and treatment of diseases as well as prevention of lifestyle-related diseases. Its main target includes 210,000 former residents of evacuation zones whose lifestyle changed drastically after the accident. Additional tests such as differential leukocyte count are performed apart from the routine tests included in the general medical check-up at the workplace or by the local government. (Based on the website of the Radiation Medical Science Center, Fukushima Medical University)

### Confidence interval

In "frequentist inference", a confidence interval is an interval defined in terms of the sampling distribution of a statistic of interest (i.e. the distribution of estimates of the statistic that would arise from repeated—generally hypothetical—realizations of data generated from the same underlying distribution as the observed data) such that, for example, the probability that a 95% confidence interval for a given parameter contains the true value of that parameter is 0.95. (Cited from UNSCEAR, 2017)

### Confinement function

A function as a protective wall to prevent diffusion of radioactive materials into the environment; At a reactor, even if radioactive materials leak from the primarily cooling system by pipe rupture, etc., it should be ensured that the confinement function of the reactor containment vessel works properly to prevent diffusion of radioactive materials into the environment.

### Containment vessel

Steel vessel enclosing a nuclear reactor containing radioactive material. It is designed, in any emergency, to keep radioactive materials inside of the vessel and to prevent the release thereof when the radioactive material is leaked from nuclear reactor.

### Controlled disposal sites

One type of disposal site where countermeasures have been taken to prevent contamination of groundwater and public waters caused by seeping water from radioactive waste. One of the countermeasures is water shielding work that covers the sides and bottom of the disposal site with plastic sheets, etc. Disposal sites are categorized into three types depending on methods of reducing influence of the waste to be landfilled on the surrounding environment, i.e., controlled type, isolated type, and stabilized type. (Based on the website of the EIC Network)

### Cooling system

A system to remove the heat generated in a reactor; There are the primary core cooling system and the emergency core cooling system.

### Core fuel

There is an area to load fuel assemblies in the inside of the reactor pressure vessel. This area is referred to as a reactor core. Nuclear fuel in the area is referred to as core fuel.

### Core melt

A situation where fuel assemblies overheat due to abnormal deterioration of the cooling capacity of a reactor, and the fuel assemblies in the reactor core or core internals melt down. (Based on the website of Fukushima Prefecture [d])

### Cosmic rays

High energy ionizing particles such as protons, neutrons, etc. from outer space. These particles produce complex compositions at the surface of the earth through nuclear reaction with nitrogen or oxygen in the air.

### Count per minute (cpm)

Number of counts per unit time when measuring radiation using a counting device (a device to count the amount of incident radiation); Number of counts per minute is indicated as cpm and number of counts per second is indicated as cps. (kcpm=1000cpm) (Based on the website of Fukushima Prefecture [d])

## D

### Decay (disintegration)

The process of spontaneous transformation of a radionuclide from unstable to

more stable states. Radiation of alpha-ray, beta-ray, gamma-ray etc. occurs in the process. (Cited from the website of Public Health England, Radiation Protection Services)

#### Declaration of a nuclear emergency situation

A declaration of an emergency situation that the Prime Minister issues based on the Act on Special Measures Concerning Nuclear Emergency (see the Act on Special Measures Concerning Nuclear Emergency) for the purpose of protecting citizens' lives, bodies and property from a nuclear disaster; Based on the declaration, the national government establishes the Nuclear Emergency Response Headquarters (headed by the Prime Minister) and provides instructions necessary for protecting citizens to nuclear operators, government organizations and relevant local governments, etc.

#### Decommissioning

Dismantling a nuclear reactor and the other related facilities for which it has been decided to discontinue operation or make adjustments to ensure that they pose no risks into the future.

#### Deliberate Evacuation Areas

Areas in municipalities located within 20km to 30km in radius from TEPCO's Fukushima Daiichi NPS where exposure doses are highly likely to reach 20mSv in one year after the accident; The designation of Deliberate Evacuation Areas is one of the physical protection measures taken after the accident at the NPS. (Based on the website of Fukushima Prefecture [d])

#### Designated waste

Contaminated waste that is confirmed to be over 8,000Bq/kg of radioactive concentration and is designated by the Minister of the Environment. The Minister of the Environment designates the waste when it is contaminated with more than 8,000Bq/kg, based on the investigation results of the contamination status of incinerated ash and such or an application submitted by the owner of the waste.

#### Detection limit

The minimum amount or concentration of a targeted radioactive material in a test sample that can be detected by a certain analysis method under appropriate management and operation. (Based on the website of the Food Safety Commission of Japan)

#### Directional dose equivalent

The dose equivalent at a point in a radiation field that would be produced by the corresponding expanded field in the ICRU sphere at a depth,  $d$ , on a radius in a specified direction,  $X$ . The unit of directional dose equivalent is joule per kilogram (J kg<sup>-1</sup>) and its special name is sievert (Sv). (Cited from ICRP, 2007)

#### Director General of the Nuclear Emergency Response Headquarters

In the event of a nuclear emergency situation as prescribed in Article 15 of the Act on Special Measures Concerning Nuclear Emergency, the Prime Minister issues a declaration of a nuclear emergency situation. The national government establishes the Nuclear Emergency Response Headquarters (headed by the Prime Minister), provides necessary instructions to nuclear operators, government organizations

and relevant local governments, etc., and also establishes the Local Nuclear Emergency Response Headquarters (headed by the Vice-Minister) at an off-site center and formulates the Joint Council for Nuclear Emergency Response. (Based on the website of Fukushima Prefecture [d])

### Dissolved Cs

See "Cesium".

### Distribution Restrictions

Based on the Act on Special Measures Concerning Nuclear Emergency Preparedness, when any agricultural products containing radioactive materials at levels exceeding the standard values are found, the national government issues distribution restrictions to prevent the distribution of products from the relevant production areas for each of such areas (for each of the present or former municipalities; regarding fishery products, additionally for each sea area, lake or river).

### Dose constraint

A prospective and source-related restriction on the individual dose from a source, which provides a basic level of protection for the most highly exposed individuals from a source, and serves as an upper bound on the dose in optimisation of protection for that source. For occupational exposures, the dose constraint is a value of individual dose used to limit the range of options considered in the process of optimisation. For public exposure, the dose constraint is an upper bound on the annual doses that members of the public should receive from the planned operation of any controlled source. (Cited from ICRP, 2007)

### Dose-response relationship

Relationship between the magnitude of a dose and the biological response in an organism, system or (sub)population. (Cited from WHO, Health Risk Assessment, 2013)

### Dosimeter

A device for measuring an individual's exposure to ionizing radiation. (Cited from UNSCEAR, 2013)

## E

### Electron

An elementary particle with low mass,  $1/1836$  that of a proton, and unit negative electric charge. Positively charged electrons, called positrons, also exist. (Cited from the website of Public Health England, Radiation Protection Services)

### Emergency core cooling system

A safety system to cool a reactor core in the event of pipe rupture in the reactor cooling system, etc. by immediately injecting coolant into the reactor core; Even if a nuclear fission chain reaction is stopped by insertion of control rods immediately in an emergency, fission products continue to generate decay heat and the fuel assemblies need to be cooled. An emergency core cooling system is used for this purpose.

### Energetically unstable (Unstable energy state)

See "Nucleus Stability/Instability".

### Enriched uranium

See "Uranium".

### Environmental monitoring

The measurement of external dose rates due to sources in the environment or of radio-nuclide concentrations in environmental media. (Cited from WHO, Health Risk Assessment, 2013)

### Environmental radiation

Naturally occurring radiation or artificial radiation in the living environment; Naturally occurring radiation includes cosmic rays from the outer atmosphere and radiation deriving from naturally occurring radioactive elements that constitute the earth's crust. Part of artificial radiation that is referred to as environmental radiation is radiation released from fallout from past nuclear testing and radiation that was generated at nuclear facilities and exists in the environment. (Based on the website of the Research Organization for Information Science and Technology)

### Epidemiological Studies

Studies of the distribution in a population of disease and other health issues as related to age, sex, race, ethnicity, occupation, economic status, or other factors. (Cited from the website of the United States Environmental Protection Agency)

### Exposure dose

A situation where a human body is exposed to radiation is referred to as exposure and the amount of radiation that a person has received is referred to as an exposure dose, which is expressed in Grays (Gy) or Sieverts (Sv). (Based on the website of the Research Organization for Information Science and Technology)

## F

### Fine-needle aspiration cytology

This diagnostic procedure entails puncturing a fine needle into suspicious lesions, aspirating cells from the lesions through a needle and inspecting the nature of the cells, i.e., malignant or not, under the microscope. (Based on the website of the National Cancer Center Japan)

### Food Sanitation Act

An Act for securing food safety and preventing the occurrence of sanitary hazards caused by eating and drinking. (Based on the website of the Ministry of Health, Labour and Welfare [b])

### Frozen soil wall

A frozen soil wall is made by freezing the surrounding ground like a wall. Thereby the flow of the underground water is blocked. The frozen soil wall reduces the inflow of underground water into reactor buildings and inhibits the generation of contaminated water. This mechanism was adopted as one of the countermeasures to inhibit the generation of contaminated water at TEPCO's Fukushima Daiichi NPS. (Based on the website of Fukushima Prefecture [d])

### Fuel clad

A thin circular tube covering fuel; A fuel clad prevents radioactive fission products from leaking from the fuel into the coolant. Zircalloy is used for fuel clads of a light-water reactor's fuel rods. (Based on the website of the Research Organization for Information Science and Technology)

### Fukushima Health Management File

An A4-sized Fukushima Health Management File is composed of three parts: the first part contains individual records such as dose measurements, health status, health checkup data, and hospital records, the second part contains leaflets about radiation etc., and the third part is "clear holders" as a storage space for record sheets. The file has been provided to each Fukushima resident so as to utilize the file for individual health management. In addition, it is an individual database about long-term health status, laboratory measurements, etc. that can be informative for future study. (Based on the website of Fukushima Prefecture [c])

## G

### Gaseous cesium

See "Cesium" and "Plume".

### Germanium semiconductor detector

A radiation detector using a germanium semiconductor; A germanium semiconductor detector has excellent energy resolution and is widely used for gamma-ray spectrometry to identify radionuclides.

### Groundwater drain

A well pumping up groundwater.

## H

### Habitation Restricted Areas

Areas designated by municipal mayors as areas where entry should be restricted and evacuation is ordered for the purpose of preventing risks on residents' lives and bodies; After the accident, areas within a 20-km radius from TEPCO's Fukushima Daiichi NPS were designated as Restricted Areas. (Based on the website of Fukushima Prefecture [d])

### Hand-held dose-rate instrument

An easy-to-carry-around instrument to measure ambient dose rates (e.g., a NaI (TI) survey meter).

### High Pressure Coolant Injection System (HPCI)

A safety system to cool a reactor core in the event of a loss of coolant in the reactor core by immediately injecting coolant into the reactor core at high pressure; One of the multiple safety systems contained in the emergency core cooling system.

### High-dose radiation

According to the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), a total dose exceeding 2,000mGy (2Gy) is referred to as high-dose radiation. (Based on UNSCEAR, 1993)



### Hydrogen explosion

A phenomenon where hydrogen precipitously reacts with oxygen to explode.

## I

### ICRP Recommendations

The basic idea (concept) and numerical standards for radiological protection recommended by the International Commission on Radiological Protection (ICRP); These are collectively referred to as ICRP Recommendations. (Based on the website of the Research Organization for Information Science and Technology)

### Inert element

An inert element does not readily enter into chemical combination with other elements. Examples are helium, argon, krypton, xenon and radon. (Cited from WHO, Health Risk Assessment, 2013)

### Infrared

A kind of electromagnetic wave in region of the spectrum comprising wavelengths in the range 700 nm to 1 mm. This wave does not ionize material but makes material warm.

### Inspection of All Rice Bags

Fukushima Prefecture measures the radioactive cesium level of rice produced in the prefecture in 2012 or later. The rice is tested on a bag-by-bag basis with radiation detectors prepared by the prefectural government. Each bag, containing 30 kilograms of rice, is inspected for safety before shipment so as to prevent the distribution of rice whose radioactive cesium level exceeds the safety standard limit. (Based on the website of Fukushima Prefecture [b])

### Intake

The activity of a radionuclide taken into the body (by inhalation or ingestion or through the skin) in a given time period or as a result of a given event. (Cited from WHO, Health Risk Assessment, 2013)

### Intensive Contamination Survey Areas

Areas where municipalities take the initiative in decontamination work; Of municipalities including areas where measured ambient dose rates were 0.23  $\mu\text{Sv/h}$  or higher, 92 municipalities in eight prefectures are designated as Intensive Contamination Survey Areas (as of the end of December 2017).

### Interim storage facility

A facility to manage and store the soil and waste. containing radioactive materials safely and intensively until their final disposal.

### International Basic Safety Standards (BSS)

The BSS is an IAEA document of General Safety Requirements published in collaboration with other international bodies such as WHO, ILO, OECS/NEA, etc., that is issued for IAEA member states in order to materialize the ICRP's recommendations on radiation protection into actual laws and guidelines. The latest version published in 2014 that incorporates the ICRP 2007 Recommendation.

### Intervention level

An intervention level is the level of avertable dose at which a specific protective action or remedial action is taken in an emergency exposure situation or chronic exposure situation. (Cited from IAEA, 1999)

### Inversion tillage

Replacement of topsoil with subsoil, thereby radioactivity concentrations are reduced in the soil layer where plants take root.

### Iodine

Iodine is a chemical element with symbol I and atomic number 53. It is the fourth halogen below fluorine, chlorine, and bromine. Stable and non-radioactive iodine is an essential nutrient that humans need and get through intake of food. Iodine is essential for the thyroid gland to function properly and produce thyroid hormones. Radioiodine, such as I-131, I-125, is used as a radioactive tracer in research and clinical diagnosis in nuclear medicine for diagnostic tests as well as in radiotherapy for hyperactive thyroid gland (hyperthyroidism). I-131 also plays a major role as a radioactive isotope present in nuclear fission products, and was a significant contributor to the health hazards from the Chernobyl accident. Radioactive iodine can disperse in gaseous or particulate form. In soil, however, it combines easily with organic materials and moves more slowly through the environment.

### Ionizing radiation

Ionizing radiation is a more precise name of all types of radiation with energy large enough to ionize a molecule. Included under this designation are radiation from radioactive sources, x-rays, short wavelength UV, particles from accelerators, particles from outer space and neutrons. Ionizing radiation is categorized into direct (primary) ionizing radiation and indirect (secondary) ionizing radiation. The former includes charged particles such as  $\alpha$ -particles,  $\beta$ -particles (electrons), positrons and the latter includes  $\gamma$ -rays, x-rays, neutrons. (Cited from Henriksen & Maillie, 2002, p.20)

### Isotope

Nuclides with the same number of protons but different numbers of neutrons. Not a synonym for nuclide. (Cited from the website of Public Health England, Radiation Protection Services)

## J

### Japan's national doses

The average exposure doses received by one Japanese person; Radiation sources include naturally occurring radiation and artificial radiation (medical radiation and radiation derived from nuclear power plant accidents, etc.). Japan's national dose is evaluated to be 2.1mSv on average from naturally occurring radiation and 3.87mSv on average from medical radiation (for diagnosis) per year. (Based on NSRA, 2011)

## K

### Kerma

Unit of exposure that represents the kinetic energy transferred to charged particles

per unit mass of irradiated medium when indirectly ionizing (uncharged) particles, such as photons or neutrons, traverse the medium. If all of the kinetic energy is absorbed “locally”, the kerma is equal to the absorbed dose. The quantity (K) is expressed in  $\mu\text{Gy/h}$  at 1 m. (Cited from WHO, Preliminary Dose Estimation, 2012)

## L

### Lanthanoid

The lanthanoid (lanthanide) series of chemical elements comprises the 15 metallic chemical elements with atomic numbers 57 through 71. They are called lanthanoids because the elements in the series are chemically similar to lanthanum.

### Linear non-threshold (LNT) model

The assumption that the risk of cancer increases linearly as radiation dose increases. This means, for example, that doubling the dose doubles the risk and that even a small dose could result in a correspondingly small risk. Using current science, it is impossible to know what the actual risks are at very small doses. (Cited from the website of the United States Environmental Protection Agency)

### Local exposure

A situation where part of the body, not the whole body, is mainly exposed to radiation.

## M

### Medical exposure

Exposure incurred by patients as part of their own medical or dental diagnosis or treatment; by persons, other than those occupationally exposed, knowingly, while voluntarily helping in the support and comfort of patients; and by volunteers in a programme of biomedical research involving their exposure. (Cited from ICRP, 2007)

### Melt of nuclear fuel

Melting of core fuel from overheating that occurs in a severe nuclear reactor accident.

### Mental Health and Lifestyle Survey

The survey aims to provide adequate care mainly for evacuees who are at a higher risk of developing mental health problems (e.g., post-traumatic stress disorder, depression, anxiety disorder) and lifestyle-related issues (e.g., obesity, problem drinking, sleep difficulties).

## N

### Nal scintillation spectrometer

A gamma-ray measurement system that detects scintillation consisting of NaI crystals is generally referred to as an NaI scintillator. (Based on the website of the Research Organization for Information Science and Technology)

### Naturally occurring radioactive materials

Materials found in nature that emit ionizing radiation that have not been moved

or concentrated artificially. K-40 is one natural radioactive material and exists in plants and human bodies.

(Cited from the website of the United States Environmental Protection Agency)

### Neutron

An elementary particle with unit atomic mass approximately and no electric charge.

(Cited from the website of Public Health England, Radiation Protection Services)

### Noble gas

An inert radioactive gas that does not readily enter into chemical combination with other elements. Examples are helium, argon, krypton, xenon and radon. (Cited from WHO, Health Risk Assessment, 2013)

### Nuclear and Industrial Safety Agency

An organization that the national government established in the Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry, for the purpose of ensuring safety of nuclear power and other types of energy and securing industrial safety; The Agency was abolished as part of the full-fledged revision of the safety regulation system in response to the accident at TEPCO's Fukushima Daiichi NPS in March 2011. (Based on the website of the Research Organization for Information Science and Technology)

### Nuclear fuel rods

A nuclear fuel rod consists of nuclear material covered with a metal clad. Multiple rods constitute a fuel assembly and multiple fuel assemblies constitute a reactor core. For light-water reactors, uranium dioxide is used for nuclear material and zircalloy is used for metal clads.

### Nuclear reactor

A device used for electricity generation. Nuclear fission can be sustained in a self-supporting chain reaction involving neutrons. In thermal reactors, fission is brought about by thermal neutrons. Nuclear energy is released by fission reactions of nuclear material. This energy is used for the electricity generation. (Cited from the website of Public Health England, Radiation Protection Services)

### Nuclear Safety Commission

The Nuclear Safety Commission was established in the Cabinet Office in 1978 as an organization that plans, deliberates and decides how to ensure safety concerning research, development and utilization of nuclear power. The accident at TEPCO's Fukushima Daiichi NPS in March 2011 triggered fundamental reform of the safety regulation system, and the Nuclear Regulation Authority was newly established as an administrative organ that integrally regulates nuclear safety on September 19, 2012, and the Nuclear Safety Commission was abolished. (Based on the website of the Research Organization for Information Science and Technology)

### Nucleus stability/instability

Whether a nucleus is stable or unstable depends on the numbers of its constituent protons and neutrons. An unstable nucleus emits radiation to change into a nucleus that is energetically more stable.

### Nuclide

A species of atom characterised by the number of protons and neutrons and, in some cases, by the energy state of the nucleus. (Cited from the website of Public Health England, Radiation Protection Services)

### Nuclide concentration

The concentration of radioisotopes in certain materials, such as soil, water, air, foodstuff, and so on

## O

### Ordinance on Prevention of Ionizing Radiation Hazards

The Ordinance on Prevention of Ionizing Radiation Hazards aims to minimize the health hazards out of radiation for workers and was established based on the Industrial Safety and Health Law. (Based on the website of the Ministry of Health, Labour and Welfare [a])

### Organization for Economic Cooperation and Development / Nuclear Energy Agency (OECD/NEA)

An international organization that aims to contribute to the development of nuclear energy as an economic energy source; A subordinate agency of the Organization for Economic Cooperation and Development (OECD).

## P

### Particulate cesium

See "Cesium" and "Plume".

### Personal dose equivalent

An operational quantity: the dose equivalent in soft tissue (commonly interpreted as the 'ICRU sphere') at an appropriate depth,  $d$ , below a specified point on the human body. The unit of personal dose equivalent is joule per kilogram ( $\text{J kg}^{-1}$ ) and its special name is sievert (Sv). The specified point is usually given by the position where the individual's dosimeter is worn. (Cited from ICRP, 2007)

### Physical attenuation

A phenomenon that the number of radioactive isotopes decrease due to radioactive decay.

### Plume (Radiation plume)

Mass of air and vapour in the atmosphere carrying radioactive material released from a source. (Cited from WHO, Preliminary Dose Estimation, 2012)

### Plutonium

Plutonium is a radioactive chemical element with symbol Pu and atomic number 94. It is an actinide metal and is produced by a nuclear reaction of uranium. Plutonium-239 is a fissile isotope and can be used for nuclear fuels and nuclear weapons. Man-made plutonium existing in the environment originates from radioactive fallout associated with nuclear weapon tests in the past. (Based on the website of Fukushima Prefecture [d])

### Post-Traumatic Stress Disorders (PTSD)

Post-traumatic stress disorder (PTSD) is a mental disorder triggered by a terrifying event, causing flashbacks, nightmares and severe anxiety for prolonged periods. (Based on the website of the Ministry of Health, Labour and Welfare [c])

### Potassium

Potassium is a chemical element with symbol K and atomic number 19. It is one of the alkali metals. Potassium in nature occurs only in ionic salts and is chemically similar to sodium. Naturally occurring potassium is composed of three isotopes, of which K-40 is the most common radioisotope in the human body. Natural potassium contains 0.0117% of K-40, which exists in animals and plants. About 4,000 Bq of K-40 is contained in the body of an adult male. Potassium ions are vital for the functioning of all living cells. Potassium is also used for agricultural fertilizer. Potassium and cesium are alkali metals and cesium absorbed in plants shows behavior similar to potassium. Therefore, after the accident at TEPCO's Fukushima Daiichi NPS, potassic fertilizer is used for crops as a measure to inhibit radioactive cesium absorption. (Based on the website of Fukushima Prefecture [d])

### Precautionary Evacuation Areas

A term used in the 2013 Report of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), which refers to areas where evacuation orders were issued from March 12 to March 15, 2011; Specifically, the term refers to Futaba, Okuma, Tomioka, Naraha, Hirono, Minamisoma, Namie, Tamura, Kawauchi and Katsurao. (Based on UNSCEAR, 2013)

### Pregnancy and Birth Survey

The survey aims to provide appropriate medical care and support to mothers who were given a Maternal and Child Health Handbook and to their children. (Based on the website of the Radiation Medical Science Center, Fukushima Medical University)

### Preparation Areas for Lift of Evacuation Order

Areas where it has been confirmed that annual accumulated doses will surely be below 20mSv and efforts are to be made for early return of residents; Passing on major roads and temporary return of residents are flexibly permitted. Physical protection measures, such as screening and dose management, are not necessary in principle upon temporary entry. (Based on the website of Fukushima Prefecture [d])

### Provisional regulation values

Provisional regulation values were regulation values that were used provisionally for regulation of the radioactivity in foodstuffs just after the accident at TEPCO's Fukushima Daiichi NPS because there had been no standard values. The provisional regulation values were used until the start of use of the standard values newly determined by the government.

### Public exposure

Exposure incurred by members of the public from radiation sources, excluding any occupational or medical exposure and the normal local natural background radiation. (Cited from ICRP, 2007)

## Q

### Quantitation limit

The minimum amount or concentration of a nuclide whose quantity can be determined by a certain analysis method. (Based on the website of the EIC Network)

## R

### Radiation Dose Map

See "Spatiotemporal Distribution of Ambient Dose Rates".

### Radiation effects

There are two major types of radiation effects: somatic effects and heritable effects. Somatic effects are classified into acute effects, which include hair loss and sterility, and late effects, which include cataracts and cancer. From the perspective of protection against radiation, somatic effects are also classified as deterministic effects (tissue reactions) and stochastic effects (cancer and heritable disorders). Although heritable effects have been demonstrated in animal studies, the effects have not been found among the offspring of atomic bomb survivors or cancer survivors treated with radiation. (Based on the website of the National Institute of Radiological Sciences)

### Radiation fluence

Radiation (particle) fluence is defined as the quotient of  $dN$  by  $da$ , where  $dN$  is the number of particles incident upon a sphere of cross-sectional area  $da$ . (Cited from ICRP, 2007)

### Radiation management

Measures and control to protect workers in charge of operations at nuclear/radiation facilities and residents living near such facilities from radiation exposure. (Based on the website of the Research Organization for Information Science and Technology)

### Radiation monitoring posts

A facility installed for monitoring environmental radiation around the nuclear facilities; In general, a facility for only measuring ambient dose rates is referred to as a monitoring post, and a facility for also measuring radioactive concentrations and meteorological data is referred to as a monitoring station. (Based on the website of Fukushima Prefecture [d])

### Radiation protection

Radiation protection is the means for protection of people from harmful effects of exposure to ionizing radiation or contamination with radioactive materials. (Based on the website of the Research Organization for Information Science and Technology)

### Radiation protection culture

Health-promoting lifestyle of people living in the contaminated area by radioactive materials, lifestyle which is backed up with knowledge and skills about radiation and radiation protection.

### Radiation weighting factor

A dimensionless factor by which the organ or tissue absorbed dose is multiplied to reflect the higher biological effectiveness of high-LET radiations compared with low-LET radiations. It is used to derive the equivalent dose from the absorbed dose averaged over a tissue or organ. (Cited from ICRP, 2007)

### Radioactive Cesium

See "Cesium".

### Radioactive cloud (plume) immersion

See "Plume".

### Radioactive decay

See "Decay (disintegration)".

### Radioactive disintegration

See "Decay (disintegration)".

### Radioactive Iodine

See "Iodine".

### Radioactive strontium

See "Strontium".

### Radiosensitivity (radiation sensitivity/sensitivity to radiation/sensitive to radiation)

Proneness of cells to be killed by radiation; As a rule, radiation exposure kills cells more easily that are dividing or programmed to divide many times in the future or in a developmental immature stage. (Based on the website of the Research Organization for Information Science and Technology)

### Reactor building

A concrete building that houses major equipment of a reactor.

### Reactor core

The area in a reactor where fuel assemblies are loaded and fission reaction occurs actively.

### Reactor core isolation cooling System

A safety system for boiling-water reactors that provides cooling water to a reactor core using a pump powered by steam in a reactor when an abnormal incident in the reactor results in preventing the ordinary system from supplying water to the reactor. (Based on the website of the Research Organization for Information Science and Technology)

### Reactor pressure vessel

A steel vessel that houses nuclear fuel, a moderator, coolant and other major components and wherein high-pressure steam is produced by fission energy. (Based on the website of Fukushima Prefecture [d])

### Reconstruction Agency

The national government's administrative agency that was organized for



proactively carrying out reconstruction work with due consideration to areas severely damaged by the Great East Japan Earthquake with the aim of achieving reconstruction as early as possible. (Based on the website of the Reconstruction Agency [b])

#### Recriticality

Criticality is a situation where a fission reaction continues without supply of neutrons from the outside. Recriticality is a phenomenon where changes in the temperature, shape or composition of a reactor core results in criticality again. (Based on the website of the Research Organization for Information Science and Technology)

#### Reduction coefficient (Dose reduction coefficient)

A ratio between the ambient dose rate due to artificial radioactive materials measured inside a building and that measured outside, when contamination by artificial radioactive materials inside the building and under the floor can be ignored; It is a value specific to a building and is also referred to as a shielding coefficient.

#### Reference level

In an emergency exposure situation or an existing exposure situation, the level of dose, risk or activity concentration above which it is not appropriate to plan to allow exposures to occur and below which optimization of protection and safety would continue to be implemented. (Cited from WHO, Preliminary Dose Estimation, 2012)

#### Repair enzymes (DNA repair enzymes)

Enzymes necessary for repairing DNA damage. Genetic mutation affecting such enzymes induces cancer proneness. There are several DNA repair mechanisms such as mismatch repair, nucleotide excision repair, homologous recombination repair, non-homologous end joining repair and so on, and each mechanism utilizes unique or shared enzymes to repair DNA damage.

#### Restricted Areas

Areas designated by municipal mayors as areas where entry should be restricted and evacuation is ordered for the purpose of preventing risks on residents' lives and bodies; After the accident, areas within a 20-km radius from TEPCO's Fukushima Daiichi NPS were designated as restricted areas. (Based on the website of Fukushima Prefecture [d])

#### Risk communication

Risk communication is a component of risk management, which is the selection of risk control options. It is the process that provides the information on which government, industry, or individual decision makers base their choices. Successful risk communication does not guarantee that risk management decisions will maximize general welfare; it only ensures that decision makers will understand what is known about the implications for welfare of the available options. (Cited from Improving Risk Communication, 1989)

## S

### Scintillation counter

A device used for radiation measurement. It contains material that emits light flashes when exposed to ionizing radiation. The flashes are converted to electric pulses and counted. The number of pulses is related to dose. (Cited from the website of Public Health England, Radiation Protection Services)

### Screening

In the field of health and medical care, "screening" means to provisionally identify persons with a disease or disorder by rapid and high through-put laboratory tests or procedures. In the field of analysis and inspection, "screening" means to provisionally select samples containing target substances or organisms, etc. by rapid and high through-put laboratory tests. Screening results are not conclusive, and further detailed examinations or diagnoses, etc. are needed to reach the final conclusions. (Based on the website of the Food Safety Commission of Japan)

### Secretariat of the Nuclear Regulation Authority (NRA)

An organization that functions as the secretariat of the Nuclear Regulation Authority newly inaugurated in September 2012 after the accident at TEPCO's Fukushima Daiichi NPS

### Self-shielding effect

An effect in measurement in a situation where radiation in the air is shielded by a person or sample subject to the measurement; For example, when a person wears a personal dosimeter around his/her chest, radiation from behind is shielded by the person him/herself upon the measurement.

### Solid cancers

Cancers originating in solid organs, as opposed to blood cancers such as leukaemia. (Cited from WHO, Health Risk Assessment, 2013)

### Source term

The types, quantities, and chemical forms of the radionuclides that encompass the source of potential for exposure to radioactivity; After a nuclear accident, a source term including its release rate is critical for risk assessment. (Based on the US Health Physics Society)

### Spatiotemporal distribution of ambient dose rates

Ambient dose rates change with time and place due to the physical decay and environmental migration of radionuclides. (Based on the website of Fukushima Prefecture [d])

### Special Decontamination Areas

Areas where the national government directly conducts decontamination work; Basically, 11 municipalities in Fukushima Prefecture which were once designated as a Restricted Area or a Deliberately-Evacuated Settlement are designated.

### Specific Spots Recommended for Evacuation

Areas that do not fall under Restricted Areas or Deliberately-Evacuated Settlements but where accumulated doses are highly likely to be over 20mSv in one year after the accident were designated as Specific Spots Recommended for Evacuation

and the national government recommended evacuation. The designation of these areas was lifted on December 28, 2014. (Based on the website of Fukushima Prefecture [a])

#### Specified Reconstruction and Revitalization Base

Zones among Areas where Returning is Difficult for which evacuation orders are lifted and where people are allowed to reside; As a result of the amendment of the Act on Special Measures for the Reconstruction and Revitalization of Fukushima (in May 2017), it was made possible to designate these zones. (Based on the website of the Reconstruction Agency [a])

#### Spent fuel pool

A spent fuel pool is a storage where nuclear spent fuels are cooled until their heat production due to the remaining radioactivity (after shutdown of a reactor) decreases sufficiently.

#### Stable cold shut-down conditions

See "Cold shut-down".

#### Stable iodine tablets

A drug containing a certain amount of non-radioactive or "cold" sodium iodide or potassium iodine; If one takes an adequate amount of the drug before inhalation or consumption of radioactive iodine after a nuclear accident, "cold" iodine fills the thyroid organ and prevents the accumulation of radioactive or "hot" iodine into the thyroid. (Based on the website of the Research Organization for Information Science and Technology)

#### Stochastic (health) effect

Health effect whose probability of occurrence depends on the dose received. Occurrence is usually many years after the exposure, and there is believed to be no threshold level of dose below which no effect will occur. (Cited from the website of Public Health England, Radiation Protection Services)

#### Stripping of topsoil (Topsoil removal)

Topsoil of farmland is to be shallowly (4 - 5cm) stripped using a tractor or other equipment to remove radioactive cesium. Radioactive cesium that fell down onto farmland is easily absorbed into soil and remained in the surface layer. Therefore, stripping and removing topsoil is effective.

#### Strontium

Strontium is the chemical element with symbol Sr and atomic number 38. Strontium has physical and chemical properties similar to those of calcium. Sr-90 is a radioisotope with a physical half of 28.8 years and is produced as a fission product in a nuclear reactor. Sr-90 is one of the concerned radionuclides in a nuclear accident because it is likely to accumulate in bones in a similar manner to calcium. (Based on the website of Fukushima Prefecture [d])

#### Subdrain

A well installed for adjusting groundwater levels around a reactor building. (Based on the website of Fukushima Prefecture [d])

### Suppression chamber

Torus-shaped steel equipment that is located at the lower part of a reactor containment vessel and stores a large amount of water; A rectangular version made of concrete is referred to as a suppression pool. It is important safety equipment that provides water for the emergency core cooling system (ECCS) in the event of a loss of cooling water due to such reasons as a primary pipe rupture accident. A suppression chamber suppresses pressure increases in a nuclear reactor. When the pressure within a reactor containment vessel increases, steam is sent to a suppression chamber to reduce the increased pressure. A suppression chamber also removes particulate radionuclides upon releasing pressure.

### Suppression pool

See "Suppression chamber".

### Suspended Cs

See "Cesium".

## T

### The Act on Special Measures Concerning Nuclear Emergency Preparedness

The Act was enacted and enforced in 1999 for the purpose of protecting citizens' lives, bodies and property in consideration of the unique characteristics of nuclear disasters. The Act specifies various matters concerning nuclear disasters and provides that in an emergency due to a nuclear disaster, the Prime Minister is to issue a declaration of a nuclear emergency situation and establish the Nuclear Emergency Response Headquarters.

### The Fukushima Health Management Survey

The accident that occurred at the Fukushima Daiichi Nuclear Power Station after the Great East Japan Earthquake on 11 March 2011 has resulted in long-term, ongoing anxiety among the residents of Fukushima, Japan. Soon after the disaster, Fukushima Prefecture launched the Fukushima Health Management Survey to investigate long-term low-dose radiation exposure caused by the accident. Fukushima Medical University took the lead in planning and implementing this survey. The primary purpose of this survey is to monitor the long-term health of residents, promote their future well-being, and confirm whether long-term low-dose radiation exposure has health effects. (Based on the website of the Radiation Medical Science Center, Fukushima Medical University)

### The Nuclear Emergency Response Headquarters

See "Director General of the Nuclear Emergency Response Headquarters".

### The radiation exposure dose

See "Exposure dose".

### Thermal electrons

Electrons which emits from the surface of highly heated metal.

### Threshold

Minimal absorbed radiation dose that will produce a detectable degree of any given effect. (Cited from WHO, Health Risk Assessment, 2013)

### Thyroid Examination

Thyroid examination covers roughly 380,000 residents aged 0 to 18 years at the time of the nuclear accident. The Preliminary Baseline Screening has been performed within the first three years after the accident, followed by complete thyroid examinations to detect newly growing tumors from 2014 onward, and the residents will be monitored regularly thereafter. (Based on the website of the Radiation Medical Science Center, Fukushima Medical University)

### Tokyo Electric Power Company (TEPCO)'s Fukushima Daiichi Nuclear Power Station (NPS) accident (2011)

An accident at TEPCO's Fukushima Daiichi NPS located on the Pacific coast in Fukushima Prefecture, which was caused by the Great East Japan Earthquake that occurred at 14:46 on March 11, 2011, and the subsequent massive tsunami. (Based on the website of Fukushima Prefecture [d])

### Trench

An underground tunnel for storing utility equipment such as power cables and pipes.

### Turbine building

At a nuclear power plant, steam pressure is converted into rotational energy by a turbine, which is further converted into electricity by a power generator. A building that houses a turbine and a power generator is referred to as a turbine building.

## U

### Undifferentiated

The developmental state of cells or organs that are immature or not differentiated. Any kind of tissues in the body contains stem cells capable of dividing and producing intermediately differentiated cells that further differentiate into mature functioning cells. In this case, stem cells are undifferentiated cells while mature functioning cells are differentiated cells.

### UNSCEAR

The United Nations Scientific Committee on the Effects of Atomic Radiation

### Uranium

Uranium is a chemical element with symbol U and atomic number 92. In nature, uranium is composed of U-238 (99.275%), U-235 (0.72%) and U-234 (0.005%). The half-lives of U-238 and U-235 are about 4.47 billion years and 704 million years, respectively. U-235 is the only naturally occurring fissile isotope, which makes it widely used in nuclear reactors.

Enriched uranium is a type of uranium in which the percent composition of U-235 has been increased through the process of isotope separation. Enriched uranium is a critical component for both civil nuclear power generation and military nuclear weapons. (Based on the website of Fukushima Prefecture [d])

## V

### Vent

An operation to reduce pressure in a reactor containment vessel when the pressure increases abnormally, by way of discharging the inner gas.

## W

### Waste within the Management Areas

Waste within areas designated by the Minister of the Environment that meet certain requirements, such as areas that are highly contaminated and require special treatment.

### Water-zirconium reaction

Zircalloy is used for fuel clads for light-water reactors. If fuel is exposed from cooling water, it becomes hot and this triggers a chemical reaction of zirconium in the fuel clad with water vapor to generate hydrogen. The phenomenon where hot zirconium reacts with water vapor and generates hydrogen in this manner is referred to as a water-zirconium reaction. (Based on the website of the Research Organization for Information Science and Technology)

### WHO

World Health Organization

### Whole-body counter

A device to measure the amount of radioactive materials taken into and deposited inside the human body from outside for the purpose of examining the internal exposure dose. (Based on the website of Fukushima Prefecture [d])

### Whole-body exposure

A situation where the whole body is evenly exposed to (external) radiation; This term is used in contrast to local exposure, which refers to a situation where only part of the body is exposed to radiation. (Based on the website of the Research Organization for Information Science and Technology)

## Z

### Zeolite

Zeolite is Aluminosilicate, a kind of clay mineral. it comprises porous crystals. Fine pores are usually around 0.2 to 1.0 nm in diameter. Zeolite has ion-exchange capacity and adsorptive capacity.

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