Exposures from the Events at the NPPs in Fukushima following the Great East Japan Earthquake and Tsunami

Yoshiharu YONEKURA

The 58th session of UNSCEAR, 23rd May, 2011

1. Impact on Public & Environment

1A. Evacuation & Sheltering during the accident

2B. Radiation exposure to residents and workers

3C. Directives on foods and drinks

1A. Evacuation & Sheltering (1/4)

- 21:23 on March11, evacuation of residents within 3km radius from Unit 1 of 1F NPP
- 5:44 on March 12, evacuation within 10km radius from 1F NPP
- 17:39 on March 12, evacuation within 10 km radius from 2F NPP
- 18:25 on March 12, evacuation within 20 km radius from 1F NPP
- On March 15, in-house stay was directed for the residents from 20 to 30 km radius from 1F NPP
- On March 15th, the Local Emergency Response Headquarter issued "the direction to administer the stable Iodine during evacuation"
- On March 25th, Chief Cabinet Secretary, Edano promoted voluntary evacuations for the residents within the area from 20 km to 30 km from 1F NPP

1A. Evacuation & Sheltering (2/4)

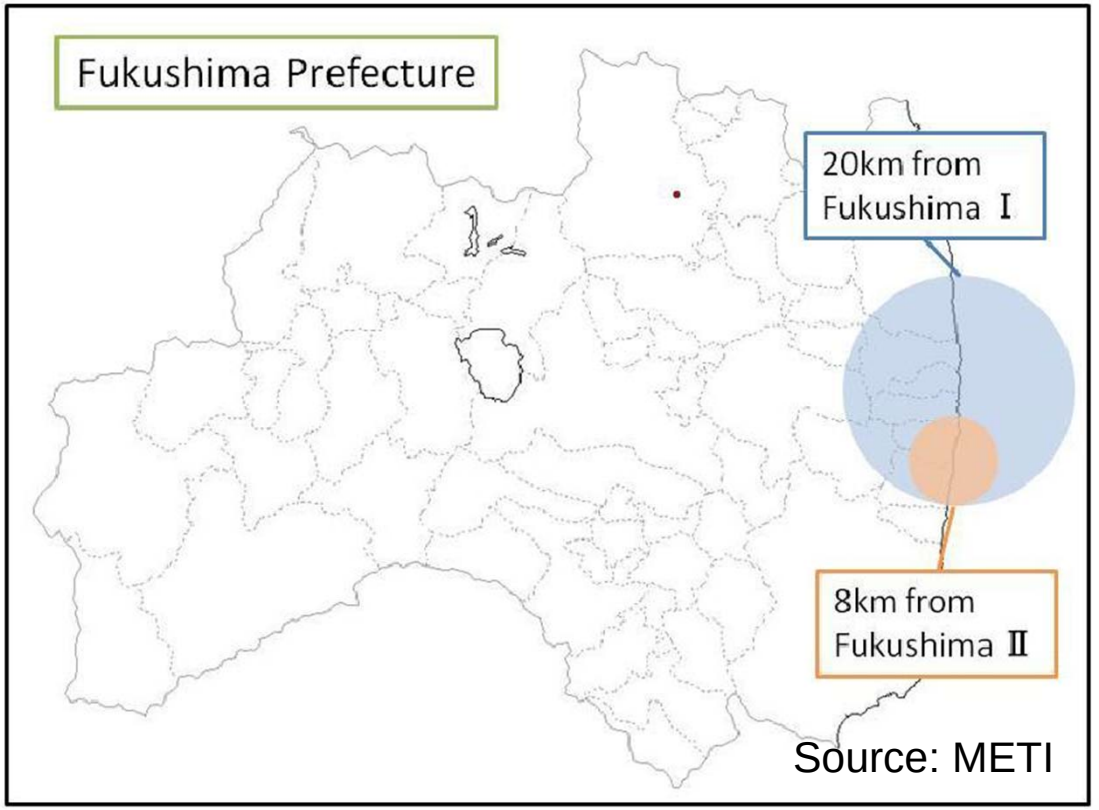
● On **April 21st**, the Prime Minister issued the following instruction to the Governor of Fukushima prefecture.

< 1F NPP >

- to establish a **restricted** area **within 20km radius from 1F NPP to prohibit the access** to the area

< 2F NPP >

- to change the evacuation area from 10km radius to **8km radius from 2F NPP.**



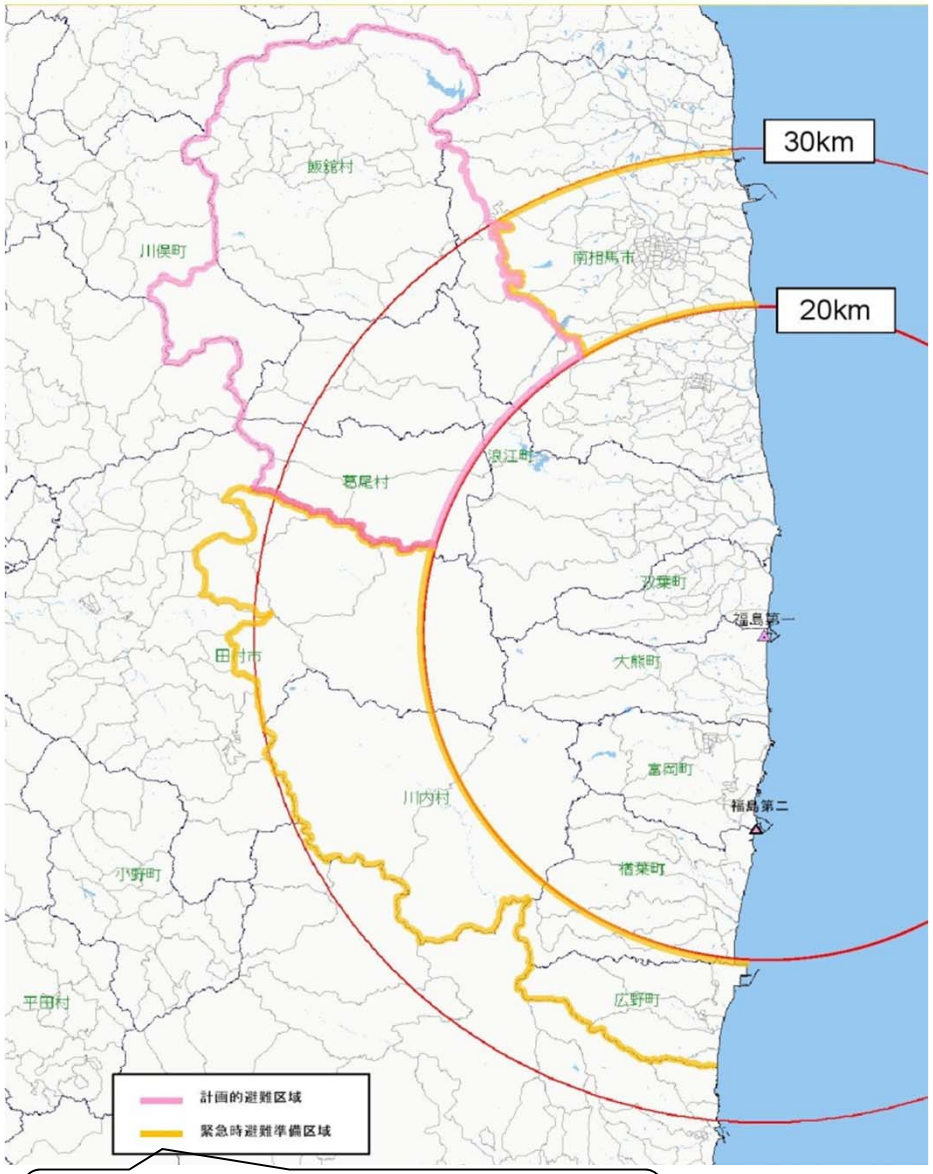
1A. Evacuation & Sheltering during the accident (3/4)

<1F NPPs>

- On **April 22nd**

- to lift the area of in-house stay between 20km and 30km radius from 1F NPP

- to establish **Deliberate Evacuation Area** as well as **Evacuation-Prepared Area** in case of Emergency for the residents and others to make a preparation to enable deliberate leaving



Source: METI

1A. Evacuation & Sheltering (4/4)

A) Deliberate Evacuation Area

- As there is a threat that the **accumulated dose reaches 20mSv in a year** since the occurrence of the accident, it is requested for the residents and others to evacuate.
- The reference level of the radiation protection in the situation of emergency exposure of ICRP and IAEA (**20 to 100mSv**) was considered.

B) Evacuation-Prepared Area in Case of Emergency

- Since the situation caused by the accident of 1F NPPs has not been settled down, the possibility of requiring actions such as **evacuation or in-house stay in cases of emergency** cannot be denied hereafter.
- Therefore in the Evacuation-Prepared Area in case of Emergency, it is required for the residents **to stay inside the house or to prepare for emergency evacuation** by themselves.

1B. Radiation exposure to residents and workers (1/2)

(Residents)

1) Local Emergency Response Headquarters started radiation screening, from March 12th to 15th , for 162 residents, and 41 of those were above the initial screening level of 6,000 cpm.

2) Local Government started the screening, from March 13th , for the public at 11 places such as health offices.

3) Among 188,758 people who received screening, 102 persons were above the 100,000 cpm, but when measured these people again without contaminated clothes, etc, the counts decreased to below 100,000 cpm, and there was no case with health problems.

4) Thyroid accumulation of I-131 was measured in more than 1,000 children (age below 15), showing no cases of thyroid dose above 50 mSv.

1B. Radiation exposure to residents and workers（2/2)

- Regulation on the **dose limit for emergency workers** was changed from 100 mSv to **250 mSv** on March 14th

(Exposure of Workers)

- Total of **30 people** had exposure dose **above 100mSv.**
- On March24, dosage above **170 mSv was confirmed on 3 workers**. Contamination of radioactive liquid on the skin of both legs was confirmed on two of them.
- Examination showed that none of them had any major systemic risk. Exposure dose on the legs was initially estimated to be maximum of **2 – 3 Sv to skin, but revealed much lower later.**
- While the level of leg and internal exposure did not require treatment, they were hospitalized for follow up and discharged without heath problem on March 28.

1C. Directives on foods and drinks

Provisional regulation values of radioactive materials in food.

	Provisional regulation values of radioactive materials in food in accordance with the Food Sanitation Act (Bq/kg)	
Radioactive iodine (^{131}I)	Drinking water, Milk, dairy products*	300
	Vegetables, Fish	2,000
Radioactive cesium (Sum of ^{134}Cs and ^{137}Cs)	Drinking water, Milk, dairy products	200
	Vegetables, Grains, Meat, eggs, fish, etc.	500
Uranium	Infant foods, Drinking water, Milk, dairy products	20
	Vegetables, Grains, Meat, eggs, fish, etc.	100
Alpha-emitting nuclides of plutonium and transuranic elements (^{238}Pu, ^{239}Pu, ^{240}Pu, ^{242}Pu, ^{241}Am, ^{242}Cm, ^{243}Cm, ^{244}Cm)	Infant foods, Drinking water, Milk, dairy products	1
	Vegetables, Grains, Meat, eggs, fish, etc.	10

*) Provide guidance so that materials exceeding 100 Bq/kg are not used in milk supplied for use in powdered baby formula or for direct drinking.

2. Radiation Monitoring

2A.Guideline for Radiation Monitoring in Japan

2B. Overview of radiation monitoring around the Fukushima-I NPP

2C. On-site monitoring

2D. Off-site monitoring

2E. Aerial monitoring

2F. Sea monitoring

2G. Build-up of monitoring system for the future

2A. Guideline for Radiation Monitoring in Japan (1/3)

Rational

1) In case of nuclear accident, the regulatory body, the provincial government and the nuclear operator must take measures on necessary disaster prevention according to the Act on Special Measures Concerning Nuclear Emergency Preparedness.

2) As part of this disaster measures, the emergency environmental radiation monitoring act is to be taken, in order to obtain the information on radioactive materials and radiation doses in the environment.

3) The Guideline for Emergency Environmental Radiation Monitoring have been established by Nuclear Safety Commission. In this guidance, the organization of monitoring team, radiation measuring instruments and materials and equipment for nuclear disaster prevention, and guidance for monitoring are prescribed.

2A. Guideline for Radiation Monitoring in Japan (2/3)

4) With regard to the practical procedures, authorized standard operation procedures have been already prepared and a series of emergency environmental radiation monitoring is to be operated in accordance with these procedures.

5) The operation of environmental, personal and contamination monitoring must be entirely made by nuclear operators and regulatory authorities, using well-calibrated radiation measuring instruments, in accordance with the approved programs on radiation protection activities by regulatory body.

6) Calibrations of the measuring instruments is appropriately performed by accredited calibration bodies using radiation and radioactive standards which are traceable to the national standards .

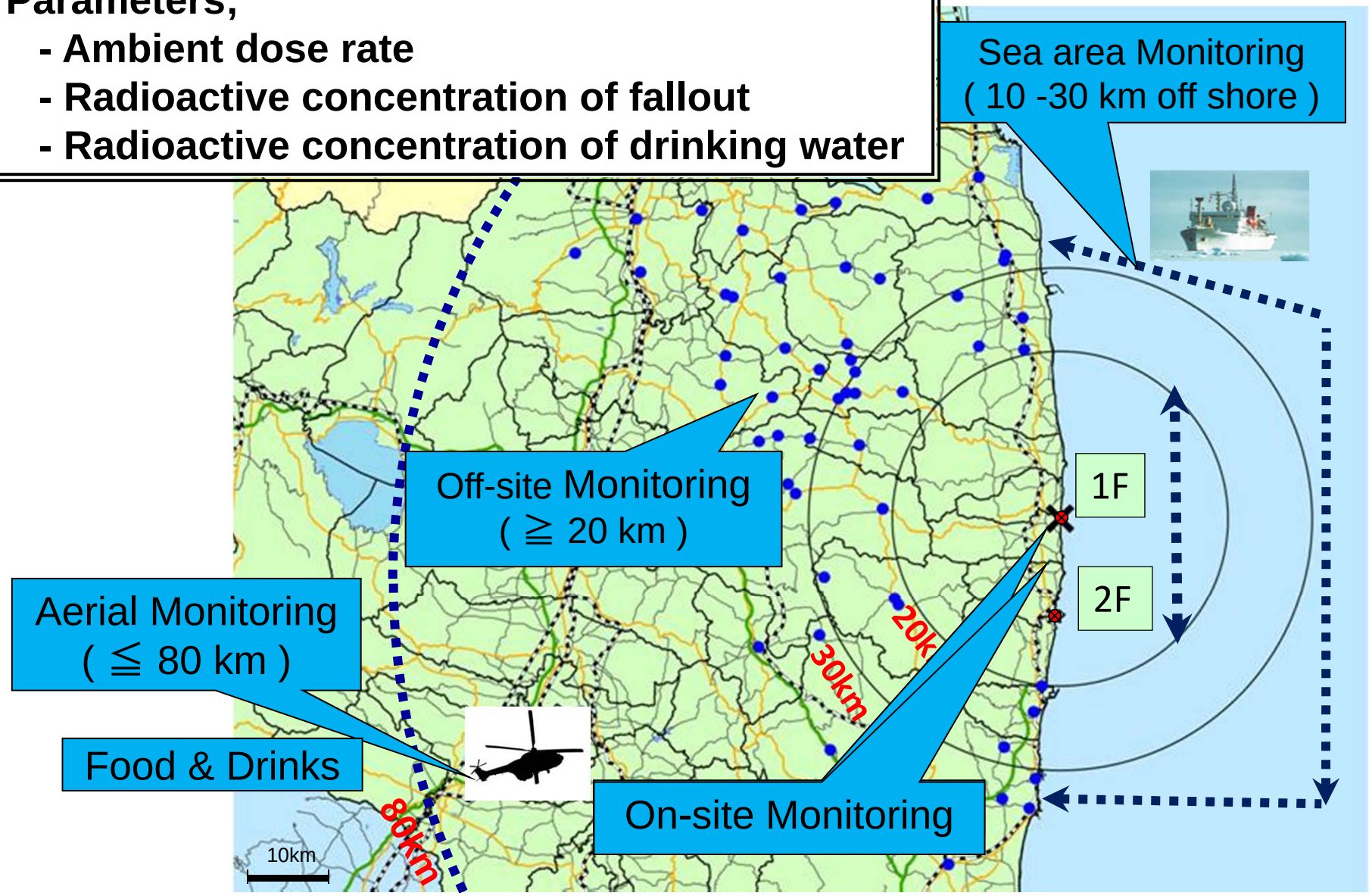
2A. Guideline for Radiation Monitoring in Japan (3/3)

Monitoring after Earthquake and Tsunami

- Emergency environmental monitoring around Fukushima-I NPP, personal monitoring for staffs and contamination monitoring programs for workers and members in public, have been operated, using the equipment which has not been damaged.
- However, many radiation measuring instruments have been severely damaged, particularly at the NPP site.
- On the other hand, many instruments were delivered to Fukushima area and used for screening and monitoring by cooperating teams from the universities, hospitals, and other organization.
- Therefore, radiation measuring instruments which are not properly calibrated might have been used in emergency situation.

2B. Overview of radiation monitoring around 1F NPP

Parameters;
- **Ambient dose rate**
- **Radioactive concentration of fallout**
- **Radioactive concentration of drinking water**

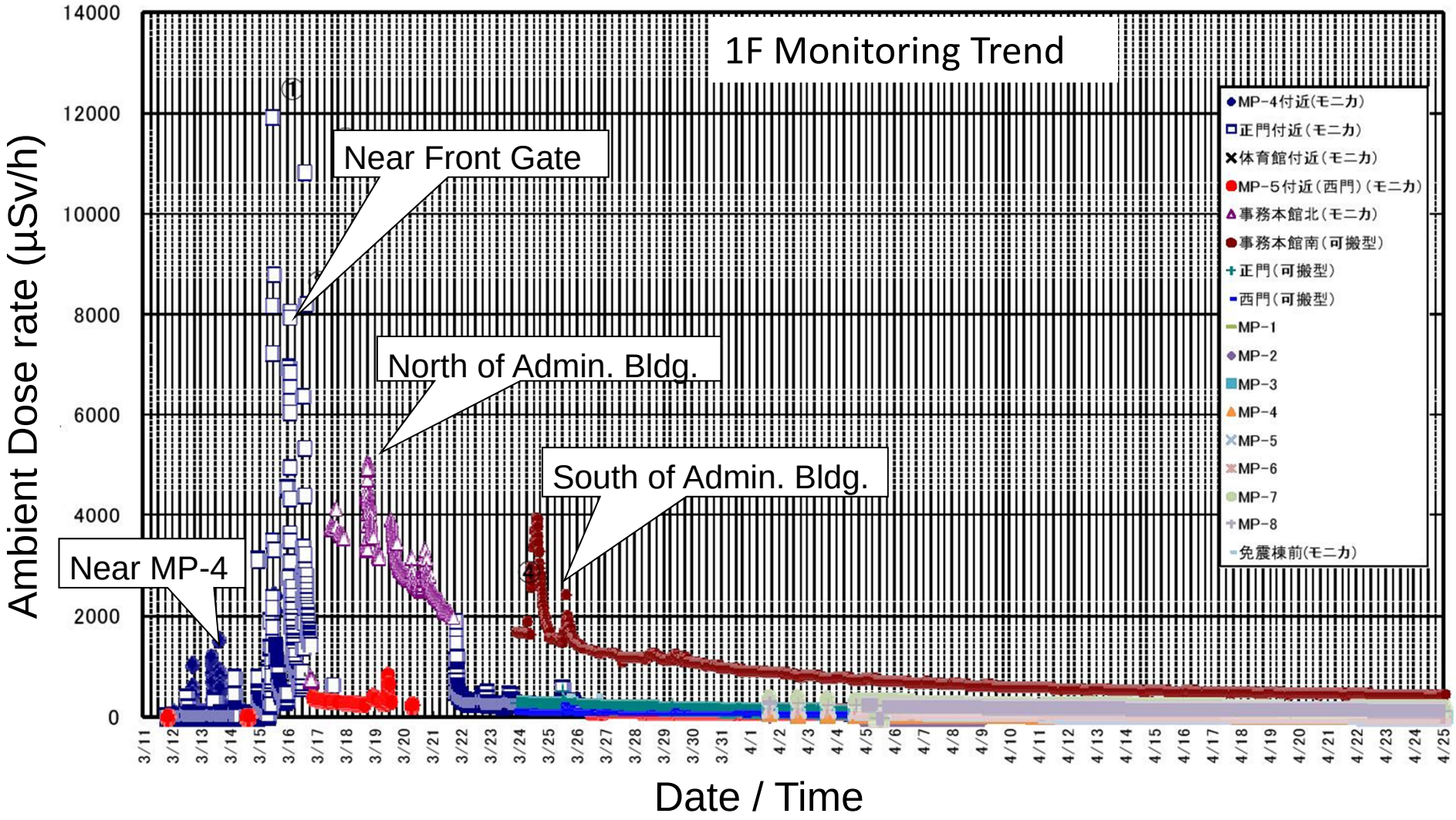


Daily results of environmental monitoring by MEXT is updated at
http://www.mext.go.jp/english/incident/1303962.htm

2C. On-site Monitoring (1/5)

1. Trend of on-site radiation level

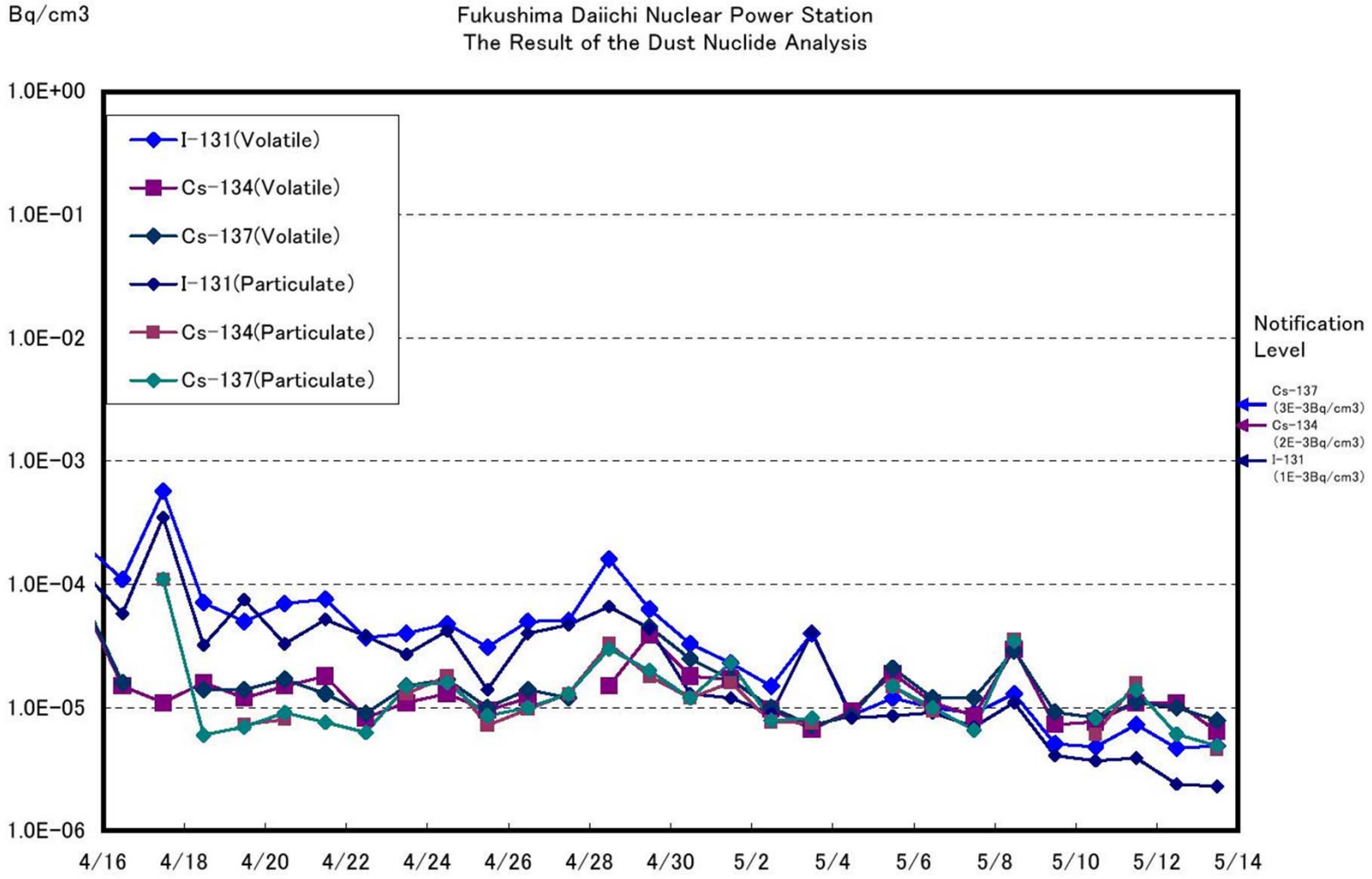
- 11,930 μSv/h was recorded near front gate on March 15th.



2C. On-site Monitoring (2/5)

2. Radioactive concentration in the air

- TEPCO conducted nuclide analyses of radioactive materials contained in the air which were collected at the site of 1F NPP.



Source: www.tepco.co.jp

2C. On-site Monitoring (3/5)

3. Radioactive concentration in soil samples

- Detected amount of Pu-238 is the same level as that of the fallout in Japan by previous nuclear tests .
- Although Pu-238, 239, and Pu-240 are detected from the samples taken on and after March 21, those values have not been greatly changed.

(Unit: Bq/kg・Dry soil)

Sampling spot ( ): Distance from the stack of Unit 1, 2	Date of sampling/ Analyses organization	Pu-238	Pu-239, Pu-240
①Playground (west-northwest approx. 500m)	April 25/ JCAC	$(1.1 \pm 0.12) \times 10^{-1}$	$(4.6 \pm 0.74) \times 10^{-2}$
②Forest of wild birds (west approx. 500m)		N.D.	N.D.
③Adjacent to industrial waste disposal facility (south-southwest approx.500m)		N.D.	N.D.
Soil in Japan *		N.D.～1.5×10^{-1}	N.D.～1.5×10^{-1}

*: Ministry of Education, Culture, Sports, Science and Technology “Environmental Radiation Database,” 1978 - 2008

2C. On-site Monitoring (4/5)

4. Radioactive concentration in subsurface water near the turbine building of 1F

- In order to verify any leakages to underground and sea, and safety, TEPCO have been implementing the sampling survey of subsurface water and seawater.

1F NPP： Results of Nuclide Analysis of Sub-drain (Data summarized on May 12)

Place of sampling	Sub-drain of Unit1	Sub-drain of Unit2	Sub-drain of Unit3	Sub-drain of Unit4	Sub-drain of Unit5	Sub-drain of Unit6	Deep well
Time of sampling	14:03, May 11th	14:08, May 11th	14:16, May 11th	14:25, May 11th	13:35, May 11th	13:23, May 11th	10:10, May 11th
Detected Nuclides	Radioactivity Density of Sample（Bq/cm3)						
I-131	2.5E+00	8.7E+01	1.4E-01	ND	ND	2.2E-02	ND
Cs-134	8.8E+00	1.3E+01	2.8E-01	2.5E-02	ND	4.6E-02	ND
Cs-137	1.0E+01	1.5E+01	2.7E-01	4.5E-02	2.2E-02	5.6E-02	ND

2C. On-site Monitoring (5/5)

5. Out flow of fluid containing radioactive materials to the ocean from areas near intake canal of 1F Nuclear Power Station Unit 2

- At 9:30 am on April 2nd, 2011, TEPCO detected water containing radiation dose over 1,000 mSv/h in the pit* where power supply cables are stored near the intake channel of Unit 2. Furthermore, there was a crack of about 20 cm length on the concrete lateral of the pit, from where the water in the pit was out flowing out.
- At 5:38 am on April 6th, TEPCO have observed stopping of spilling of water to the ocean from the crack on the concrete lateral of the pit.

* In addition to above place of collection, Data are summarized for other Units.

2C. On-site Monitoring (5/5)

< Fukushima Daiichi Nuclear Power Station (1F) >

（Data summarized on May 13）

Place of Collection	Shallow Draft Quay		North intake canal (U 1-4) (outside the silt fence)		Unit 1 (outside the silt fence)		Unit 1 (inside the silt fence)		Unit 2 (outside the silt fence)		Limit by Regulation (Bq/cm^3) (L)
Time of sampling	6:55 May 12th		7:09 May 12th		6:20 May 12th		6:15 May 12th		7:18 May 12th		
Detected nuclide	Bq/cm^3 (Q)	Q/L	Bq/cm^3 (Q)	Q/L	Bq/cm^3 (Q)	Q/L	Bq/cm^3 (Q)	Q/L	Bq/cm^3 (Q)	Q/L	
I-131	1.6E-01	4	3.0E+00	75	3.1E+00	78	2.2E+00	55	4.1E+00	100	4E-02
Cs-134	3.7E-01	6.2	1.2E+01	200	1.2E+01	200	7.9E+00	130	1.4E+01	230	6E-02
Cs-137	3.6E-01	4	1.3E+01	140	1.3E+01	140	8.5E+00	94	1.5E+01	170	9E-02

2D. Off-site Monitoring

1. Radiation monitoring

2. Cumulative doses measured

3. Radioactive concentration of Land samples
   (Weed, Soil, pond water)

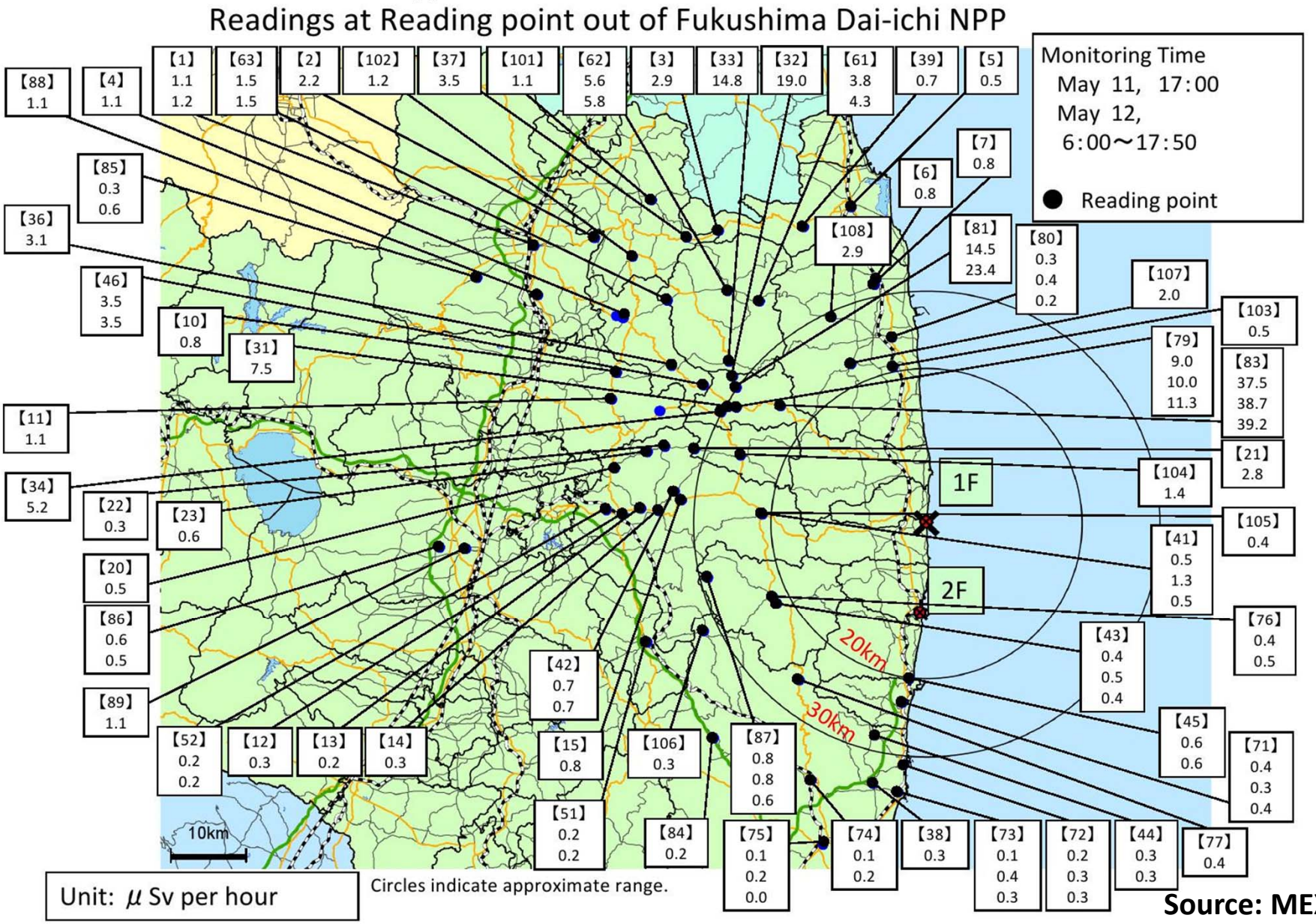
4. Radioactive concentration of Dust samples

5. Air-borne monitoring by MEXT and US DOE

6. Sea area monitoring

2D. Off-site Monitoring

1. Radiation monitoring

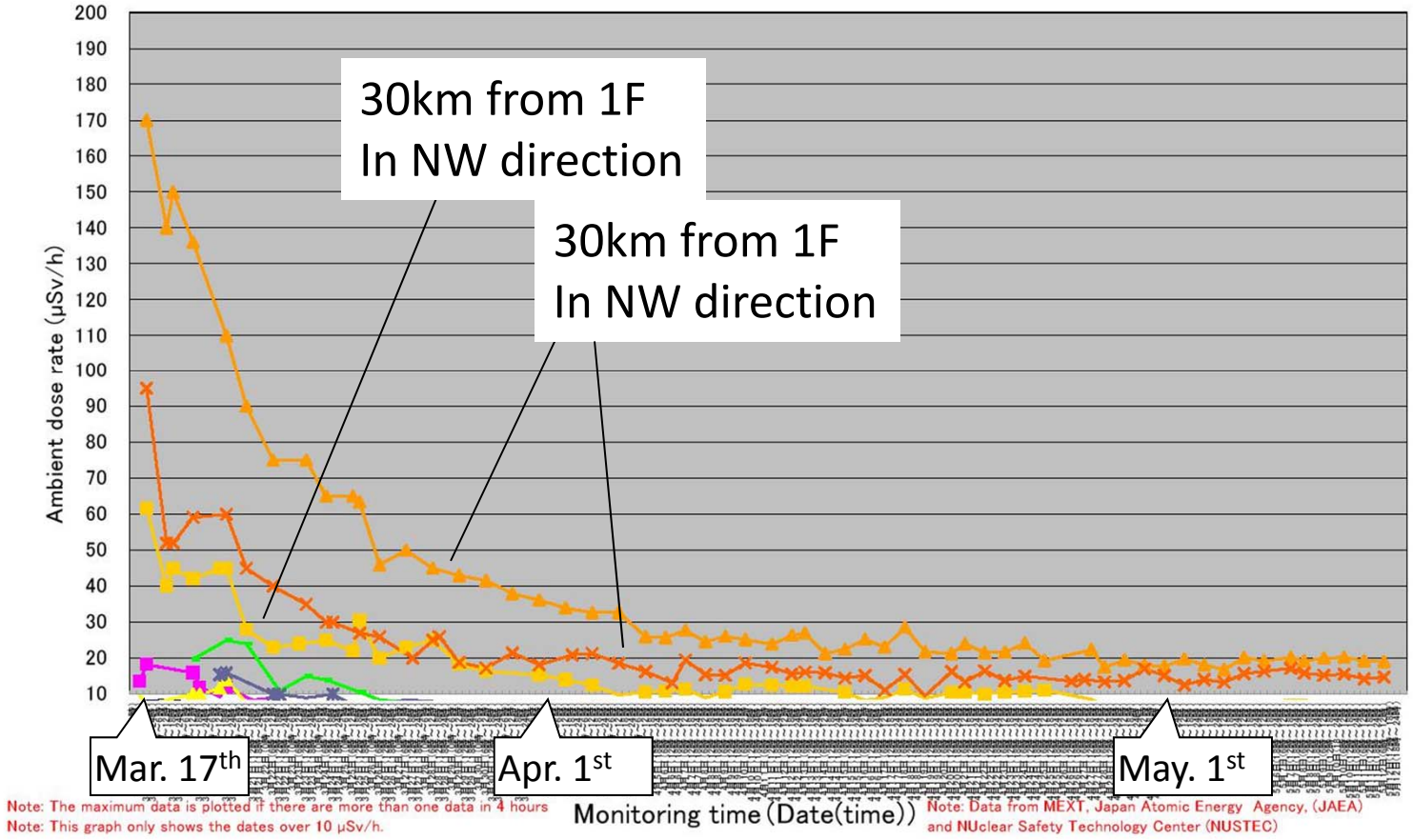


Source: MEXT

2D. Off-site Monitoring

1. Radiation monitoring

- Overall radiation level has tended down since March 17th.
- The highest value recorded at Monitoring Point #32 has peaked out at 170 μSv/h and has been declining since then.



Ambient dose rate monitoring at monitoring post outside of 20km zone of 1F

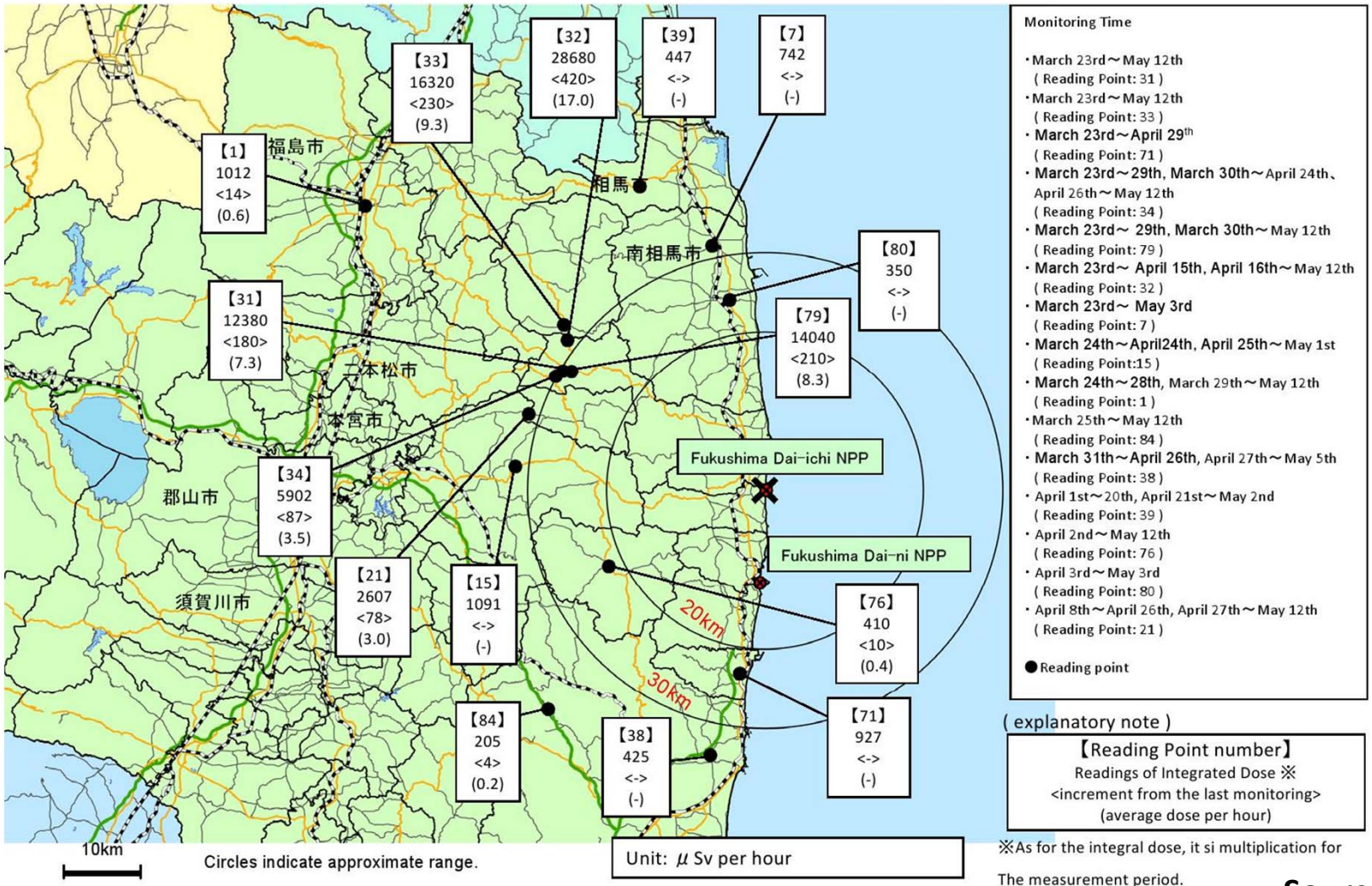
Source: MEXT

2D. Off-site Monitoring

2. Cumulative doses measured

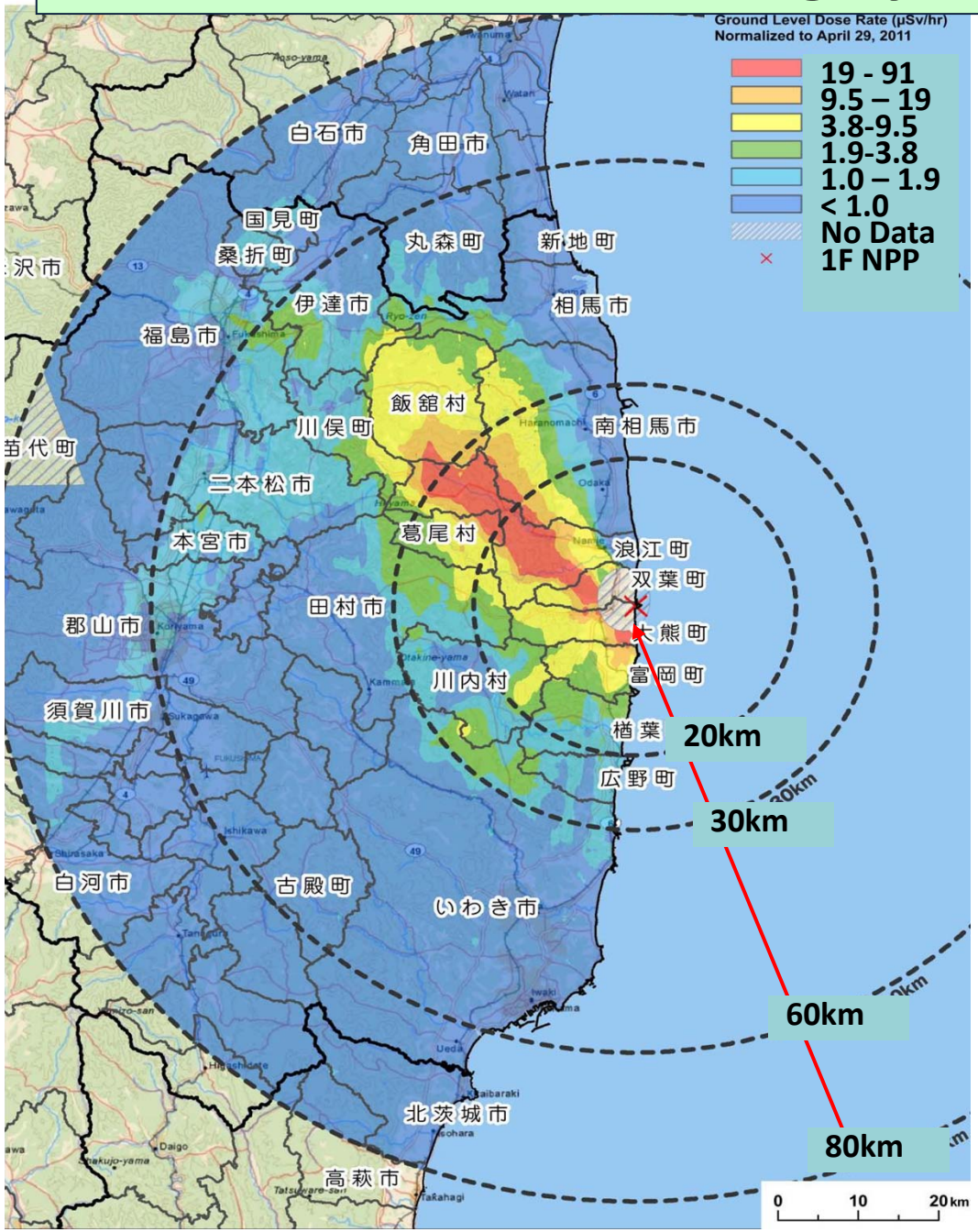
- Radiation level cumulatively measured since March 23th topped 28,680μSv at #32, 30km North West from 1F.

Readings of Integrated Dose at Reading point out of Fukushima Dai-ichi NPP



Source: MEXT

2E. Air-borne monitoring by MEXT and U.S. DOE (1/2)



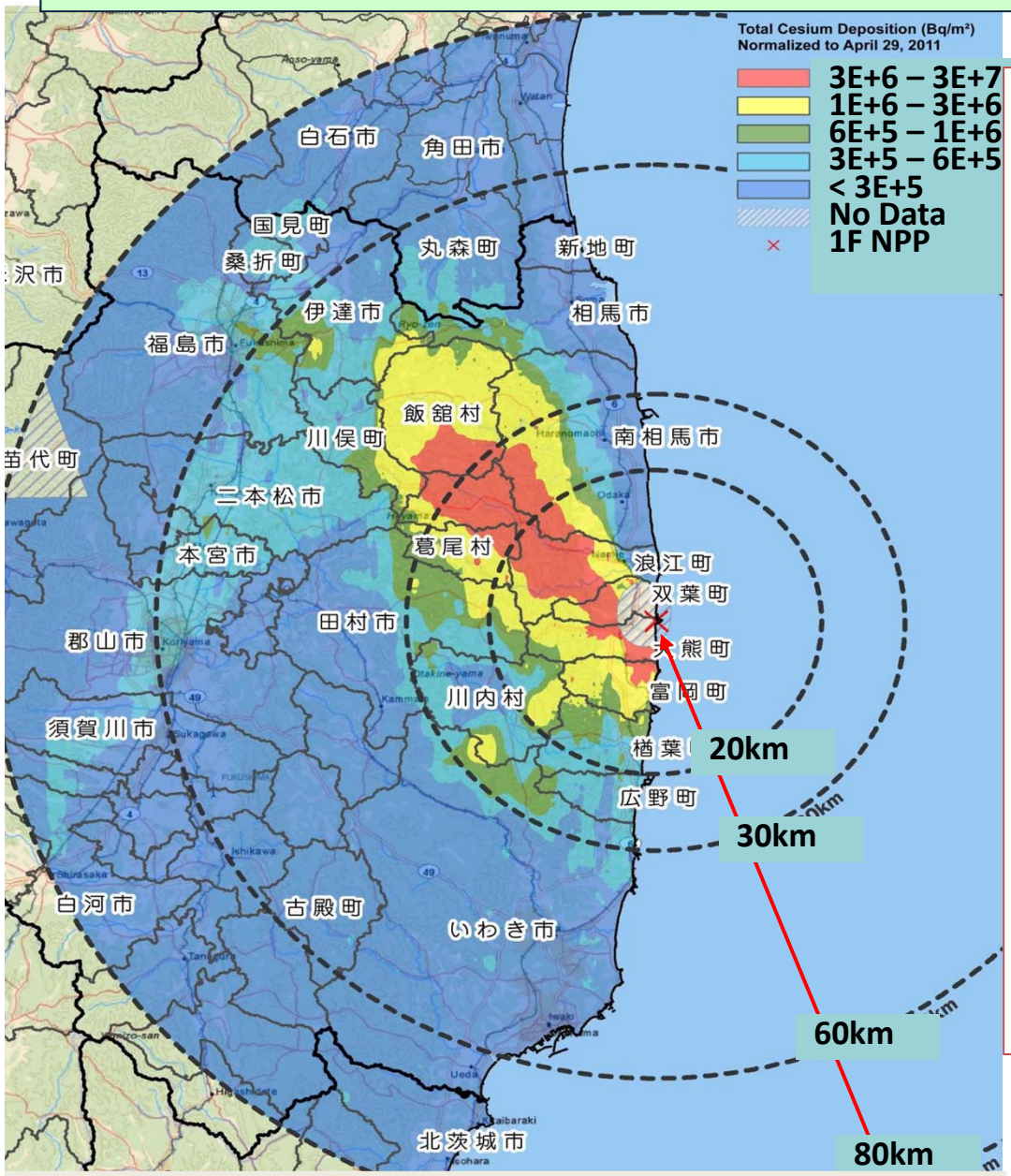
- Assessment of ambient dose rate on 1 m from the ground surface and Cesium deposition inside the 80 km zone of 1F was carried out.

- The map was prepared based on results obtained from April 6th to 29th by a small airplane and two helicopters, in total of 42 flights.

- Decay of radioactive substances was considered and actual readings were converted into values as of the last survey date of April 29th .

Source: MEXT

2E. Air-borne monitoring by MEXT and U.S. DOE (2/2)



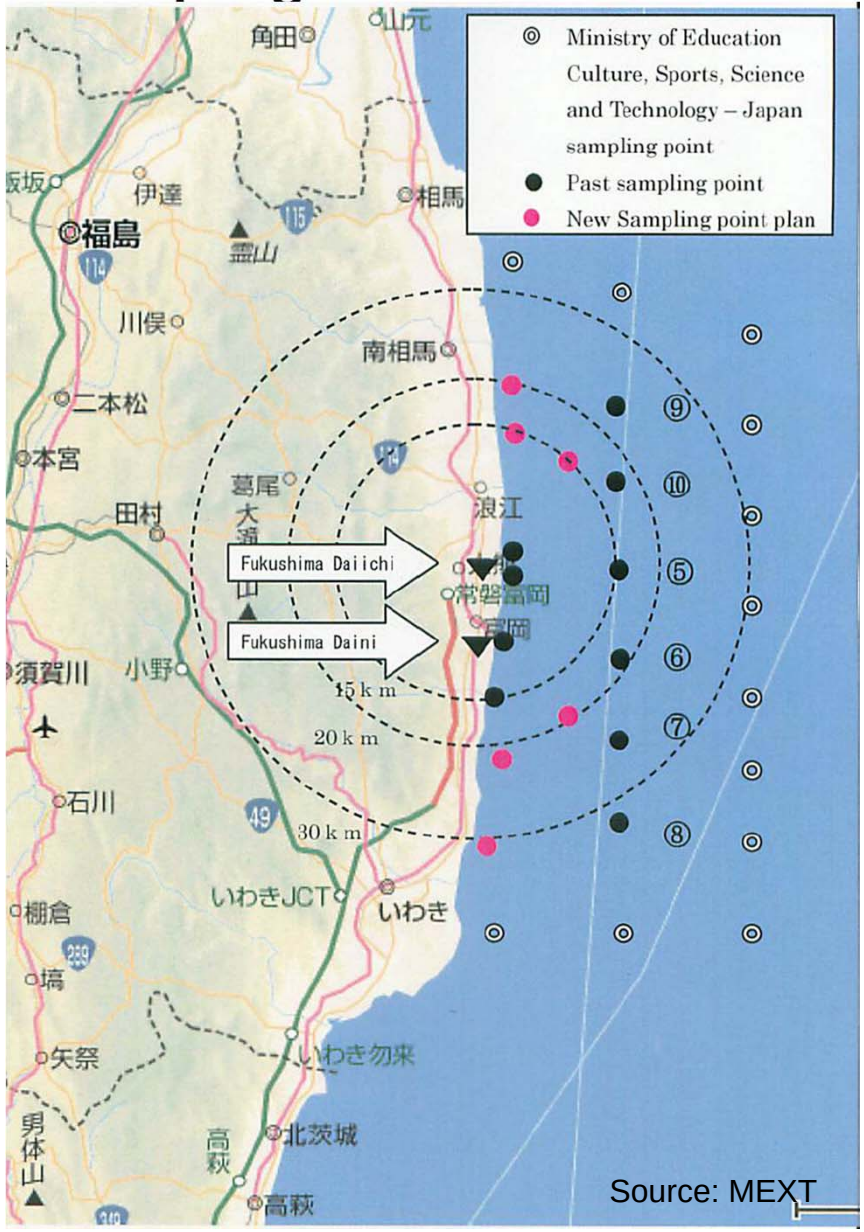
Results of total deposition of Cs-134 and Cs-137

- The deposition of Cs-134 in the ground was calculated based on the results of air-borne monitoring and of measurements which DOE took on the ground using a gamma-ray analysis.
- Based on the results of DOE measurements of Cs-134 on the ground using a gamma-ray analysis, and analysis values of Cs-137, the deposition of Cs-137 in the ground was calculated from the results of accumulated Cs-134.

Source: MEXT

2F. Sea Area Monitoring

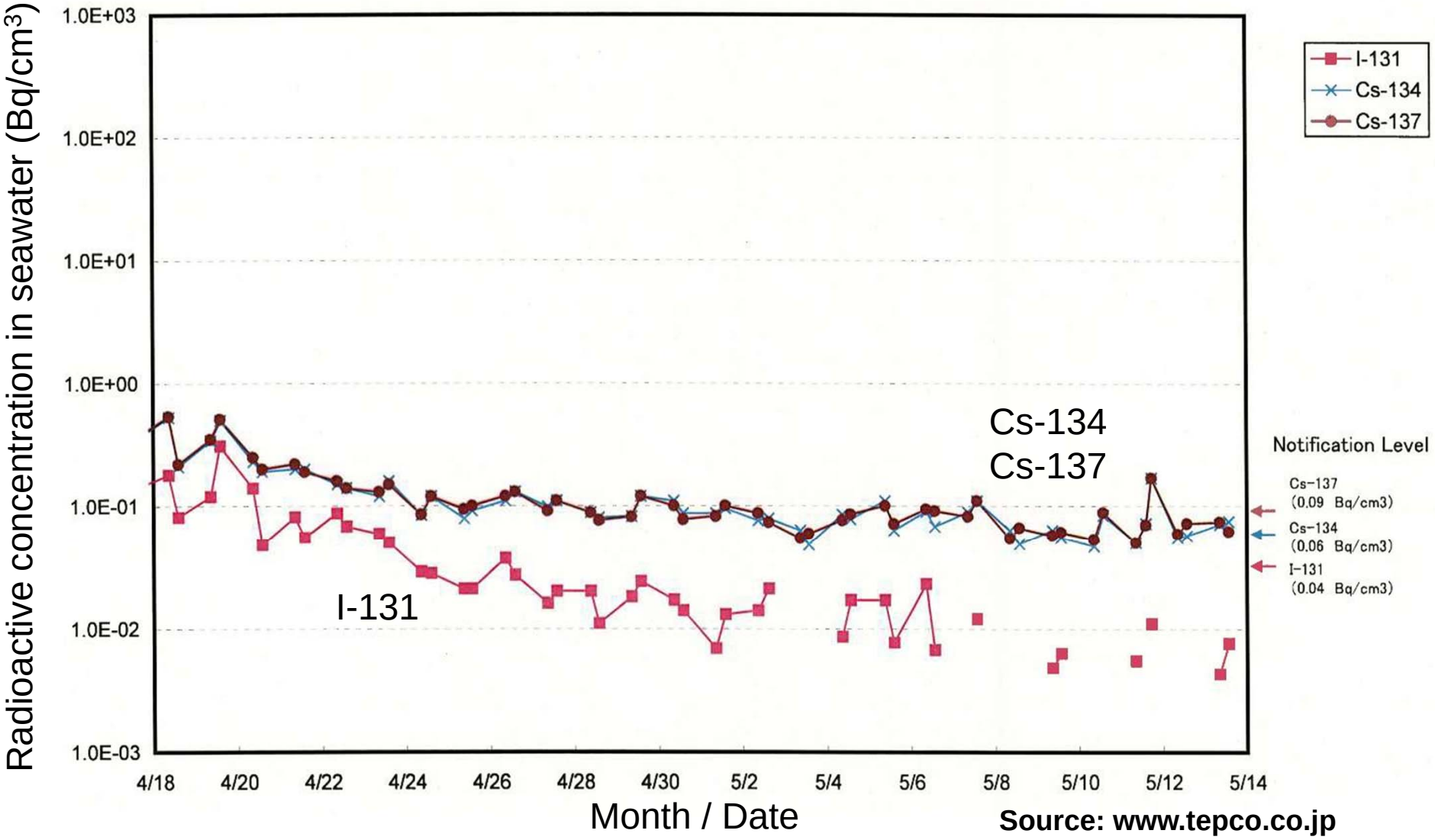
1. Sampling Point of Sea Area Monitoring



- MEXT have conducted seawater sampling surveys at 12 points, from surface water (1m from the sea surface) and sub-surface (10 m above the sea bottom) around 30km off-shore Fukushima Pref.
- TEPCO have conducted seawater sampling surveys at 4 points, off the shore and 6 points, 15 km off the shore of 1F.
- Since April 17, TEPCO have also conducted sampling surveys at 4 points, 3 km off the shore and two points, 8 km off the shore of 1F.

2F. Sea Area Monitoring

2. Radioactive Concentration of Seawater at South Discharge Channel of 1F (Bq/cm^3)



Source: www.tepco.co.jp

2G. Build-up of monitoring system for future

- **Main Analytical Body of Monitoring by MEXT**

  National Institute of Radiological Sciences
  Japan Atomic Energy Agency
  Japan Agency for Marine-earth Science and Tecnology
  Nuclear Safety Technology Center
  Japan Chemical Analysis Center
  Universities *etc.*
  U.S. Department of Energy (Aerial monitoring)

- **Strengthen monitoring by MEXT in response to the "Enforced Plan on Environmental Monitoring"**
  - Off-site Monitoring
  - Aerial Monitoring
  - Sea Area Monitoring
  - Construct distribution map for ambient dose rate, deposition of I-131, Cs-137, and accumulated dose etc. Soil sampling and analysis will be done by Ministry of Agriculture, Forestry and Fisheries, JAEA, and other relating organizations.

3. Information Sharing with International Community

3. Information sharing with international community

1. Daily Notification by NISA

(1) ENAC Website (IAEA)

(2) IEC (IAEA)

(3) Foreign Media Briefing

(4) Briefings for Diplomatic Representatives in Tokyo

(5) English information on the Web

- Nuclear and Industrial Safety Agency:
  http://www.nisa.meti.go.jp/english/index.html
- Office of Prime Minister :
  http://www.kantei.go.jp/foreign/index-e.html

3. Information sharing with international community

2. IAEA

(1) Technical Briefing on March 21st

Following the special meeting of the IAEA Board of Governors, NISA officials briefed the member state representatives on the overview of the earthquake itself as well as the status of and ongoing measures to address the Fukushima NPP accident.

(2) Side event on the “Fukushima Daiichi Accident and Initial Safety Measures Worldwide” on April 4th

NISA and MEXT officials explained the member state representatives the Status of Fukushima Daiichi NPPs and monitoring, action taken and Future plan as well as the implementation on emergency safety measures.

3. Information sharing with international community

3. ICRP

ICRP Main Commission Meeting on April 17 - 21

4. OECD

MDEP Steering Technical Committee on April27-29

OECD/NEA Steering Committee on April 28-29

CNRA Highlevel Senior Task Group on May 4-6

OECD/NEA 69th CRPPH meeting on May 17-19

5. WHO

63rd World Health Assembly on May 17 – 21

Technical briefing on May 17

Summary

After the great earthquake and tsunami in eastern Japan, the NPP (Fukushima-Daiichi) was severely damaged and a significant amount of radioactive material was released to the environment.

In order to limit and reduce the exposures, counter-measures including evacuation from surrounding area, sheltering, restrictions on consumption of water and certain food products were taken by the government.

With regard to the workers, operational staff and emergency response personnel were exposed to certain levels of radiation in managing the emergency situation.

Since there has been much concern about the levels of exposure and effects both on general public and workers, we are prepared to collect and offer further information, hoping to share the experience and knowledge of the accident with the international community.