

# **The 2011 off the Pacific coast of Tohoku Pacific Earthquake and the seismic damage to the NPPs**

**4<sup>th</sup> April, 2011**

**Nuclear and Industrial Safety Agency (NISA)  
Japan Nuclear Energy Safety Organization (JNES)**

**Japan**

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Note: Some date in this material may be incorrect. Especially, all the plant parameters were lost during some period in the accident and some parameters are apparently inconsistent among them.

# 1. Outline of earthquake and nuclear reactors



Photo: City official in Miyako, Iwate Prefecture



Source: Mainichi News Papers  
(Photo: Mr. Hiroshi Maruyama)

# 1-1. 2011 off Tohoku Pacific Earthquake

Fukushima Dai-ichi NPP



Source: [www.tepco.co.jp](http://www.tepco.co.jp)



Epicenter

Fukushima Dai-ni NPP



Source: [www.tepco.co.jp](http://www.tepco.co.jp)

- Occurred 14:46 March 11, 2011
- Magnitude: 9.0 Mw
- Epicenter location: 38° 6'N and 142° 51'E, and 24km in depth
- It is said that the height of tsunami attacked Fukushima NPP was more than 14m

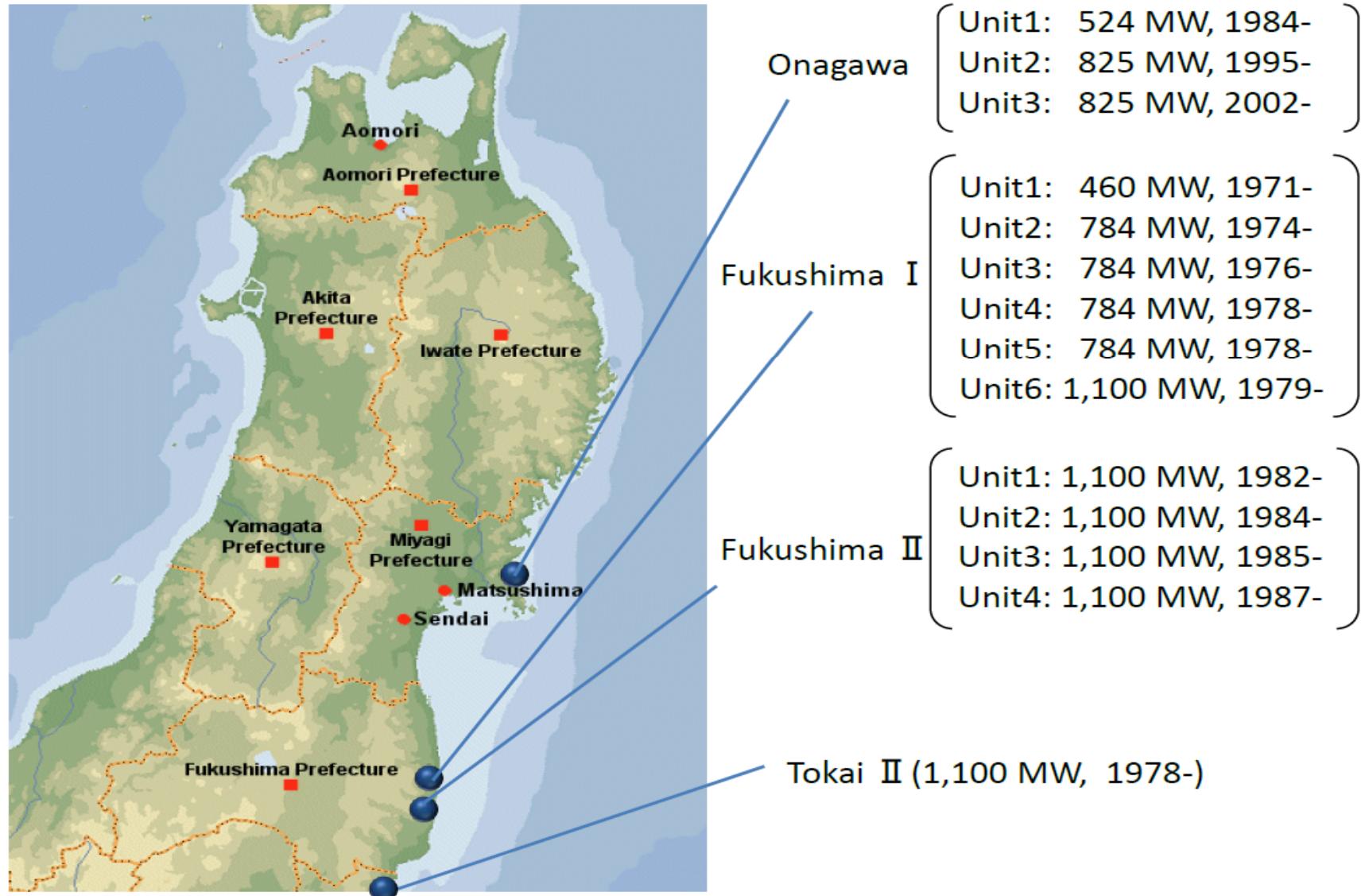
## 1-2. Tsunami after the earthquake

- East coast of northern area in the main island of Japan is seriously damaged
- As of April 4, 12,175 people are dead and 15,489 people are missing



## 1-3. Nuclear reactors near epicenter of the earthquake

### Location of the Nuclear Installations



## 1-4. Automatic shut-down of nuclear reactors

- **11 reactors were automatically shut-down**

- Onagawa Unit 1,2,3
- Fukushima Dai-ichi (I) Unit 1,2,3
- Fukushima-Dai-ni (II) Unit 1,2,3,4
- Tokai Dai-ni (II)

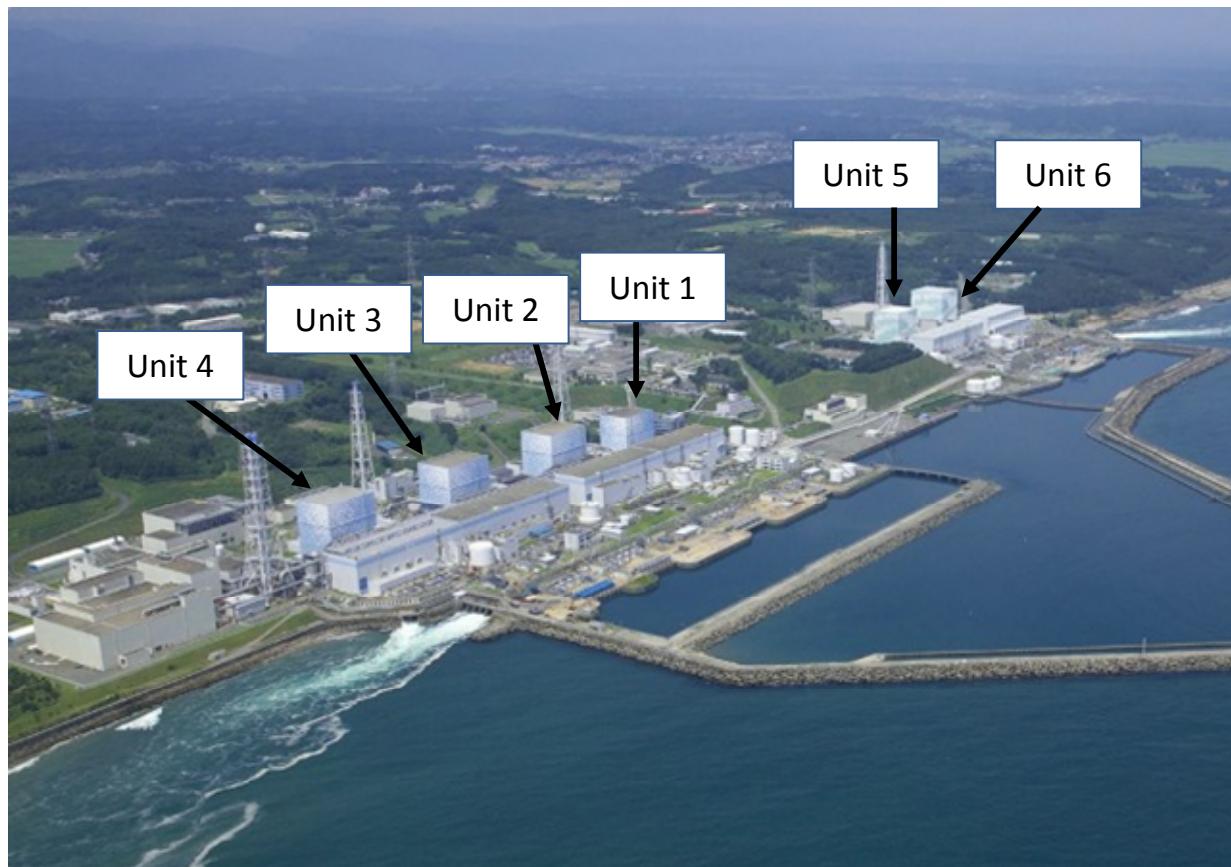
- **3 reactors were under periodic inspection**

- Fukushima Dai-ichi (I) Unit 4,5,6

- After the automatic shut-down, the Unit 1-3 at Onagawa Nuclear Power Station, the Unit 3 at Fukushima II Nuclear Power Station, and the Unit at Tokai II Nuclear Power Station have been cold shut down safely.

- As for the unit 1,2,4 at Fukushima II Nuclear Power Station, the operator of the station reported NISA nuclear emergency situation because the temperature of the suppression pools became more than 100 °C, but afterward the three units have been cold shut down.

## 2. Outline of Fukushima Dai-ichi NPS



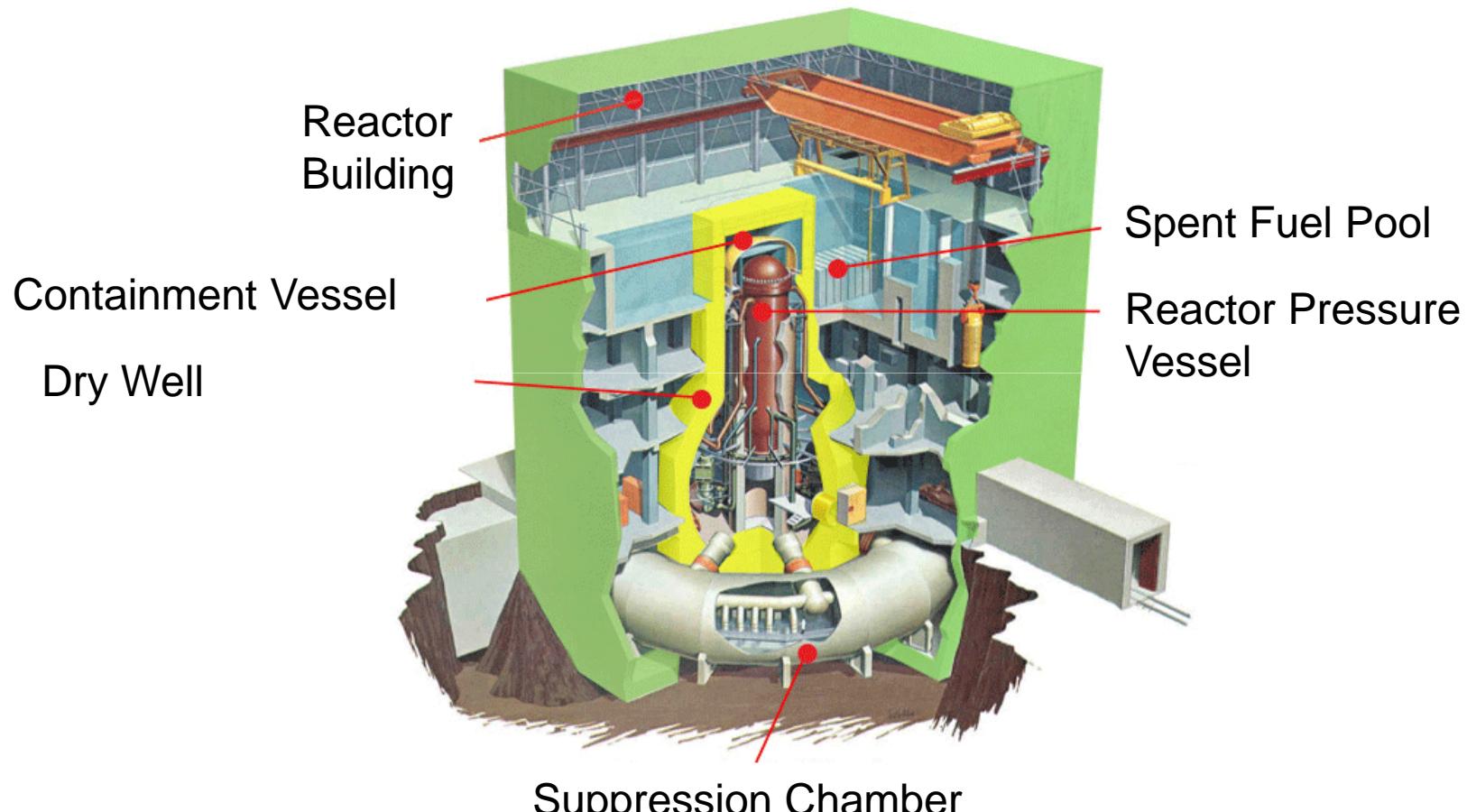
Source: TEPCO

## 2-1. Summary of Fukushima Dai-ichi NPS

	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6
	BWR-3	BWR-4	BWR-4	BWR-4	BWR-4	BWR-5
PCV Model	Mark-1	Mark-1	Mark-1	Mark-1	Mark-1	Mark-2
Electric Output (MWe)	460	784	784	784	784	1100
Max. pressure of RPV	8.24MPa	8.24MPa	8.24MPa	8.24MPa	8.62MPa	8.62MPa
Max. Temp of the RPV	300°C	300°C	300°C	300°C	302°C	302°C
Max. Pressure of the CV	0.43MPa	0.38MPa	0.38MPa	0.38MPa	0.38MPa	0.28MPa
Max. Temp of the CV	140°C	140°C	140°C	140°C	138°C	171°C(D/W) 105°C(S/C)
Commercial Operation	1971,3	1974,7	1976,3	1978,10	1978,4	1979,10
Emergency DG	2	2	2	2	2	3*
Electric Grid	275kV × 4				500kV × 2	
Plant Status on Mar. 11	In Operation	In Operation	In Operation	Refueling Outage	Refueling Outage	Refueling Outage

\* One Emergency DG is Air-Cooled

## 2-2. Overview of Mark-1 Type BWR (Unit 1,2,3 and 4)



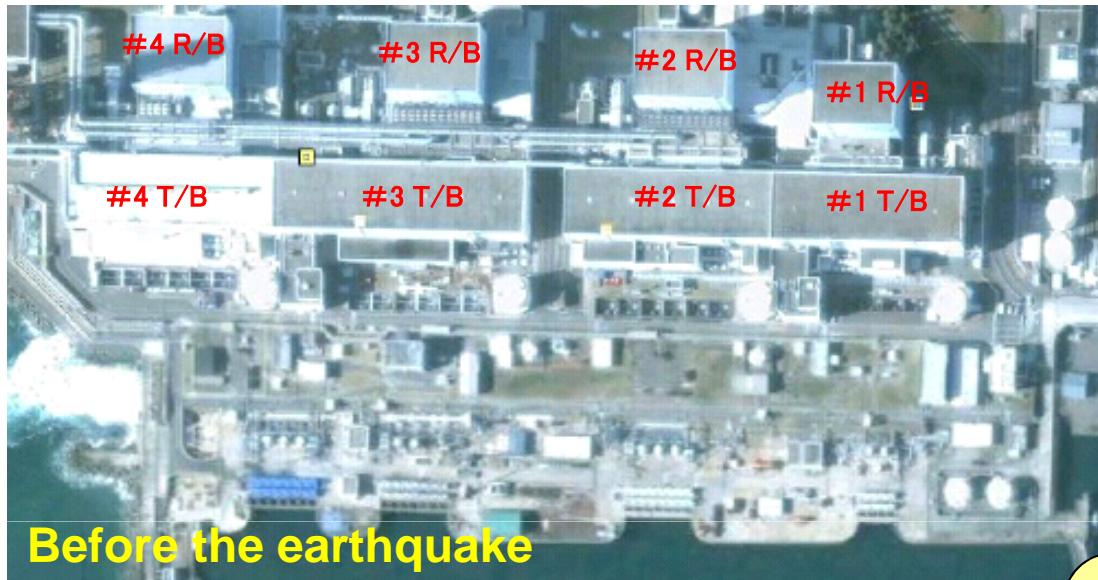
Source: Nuclear Energy Institute (NEI)

### **3. Report concerning incidents at Unit 1 through 6 in the Fukushima Dai-ichi NPS**



Source: TEPCO

### 3-1. Satellite view of Fukushima Dai-ichi NPP



Source: Google Earth



© 2011 Geosurve Consulting  
Image © 2011 DigitalGlobe

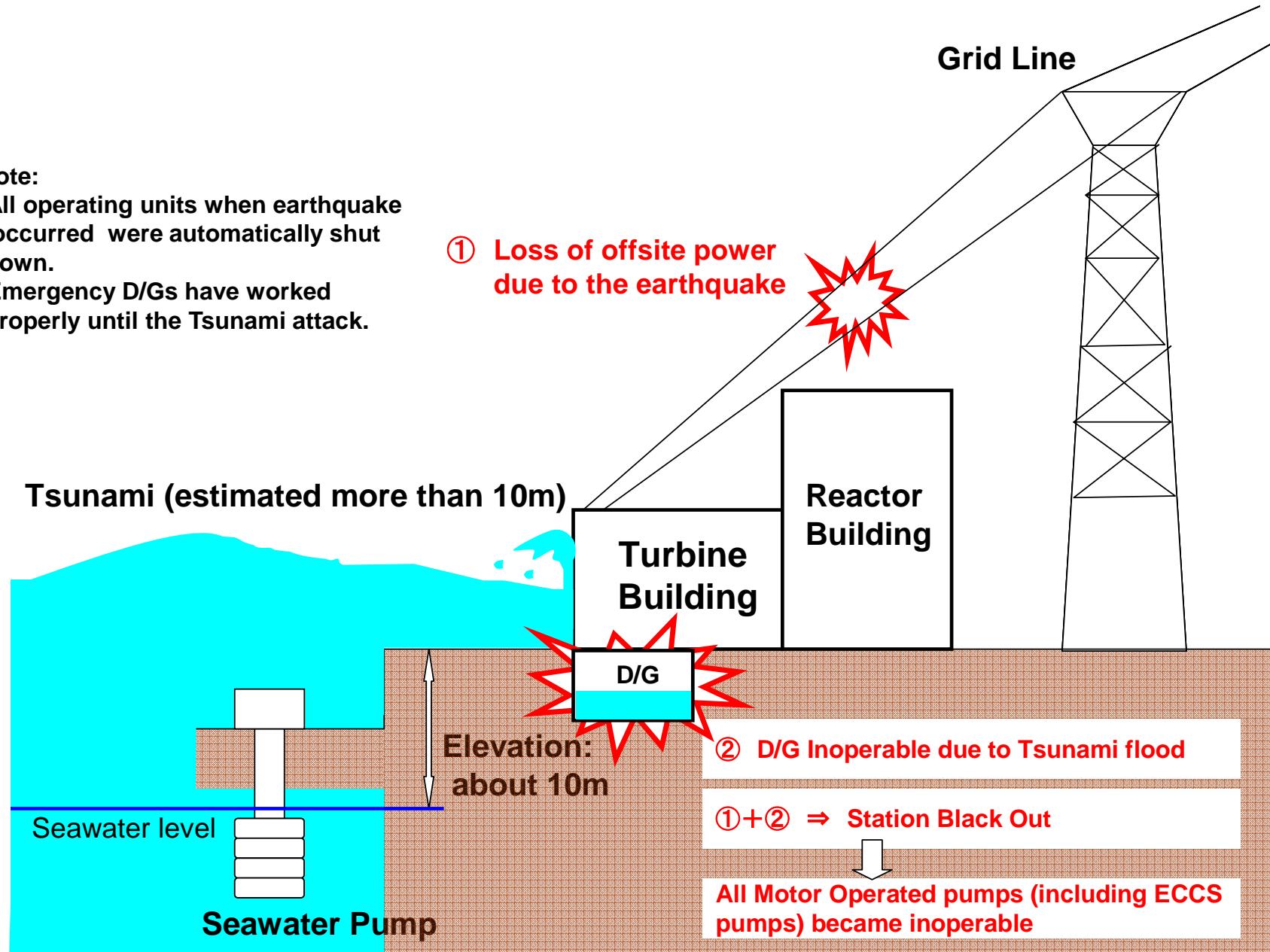
Many structures facing the bay are destroyed

Source: Google Earth

### 3-2. Major root cause of the damage

Note:

- All operating units when earthquake occurred were automatically shut down.
- Emergency D/Gs have worked properly until the Tsunami attack.



### 3-3. Accident Progression at Unit 1 Reactor



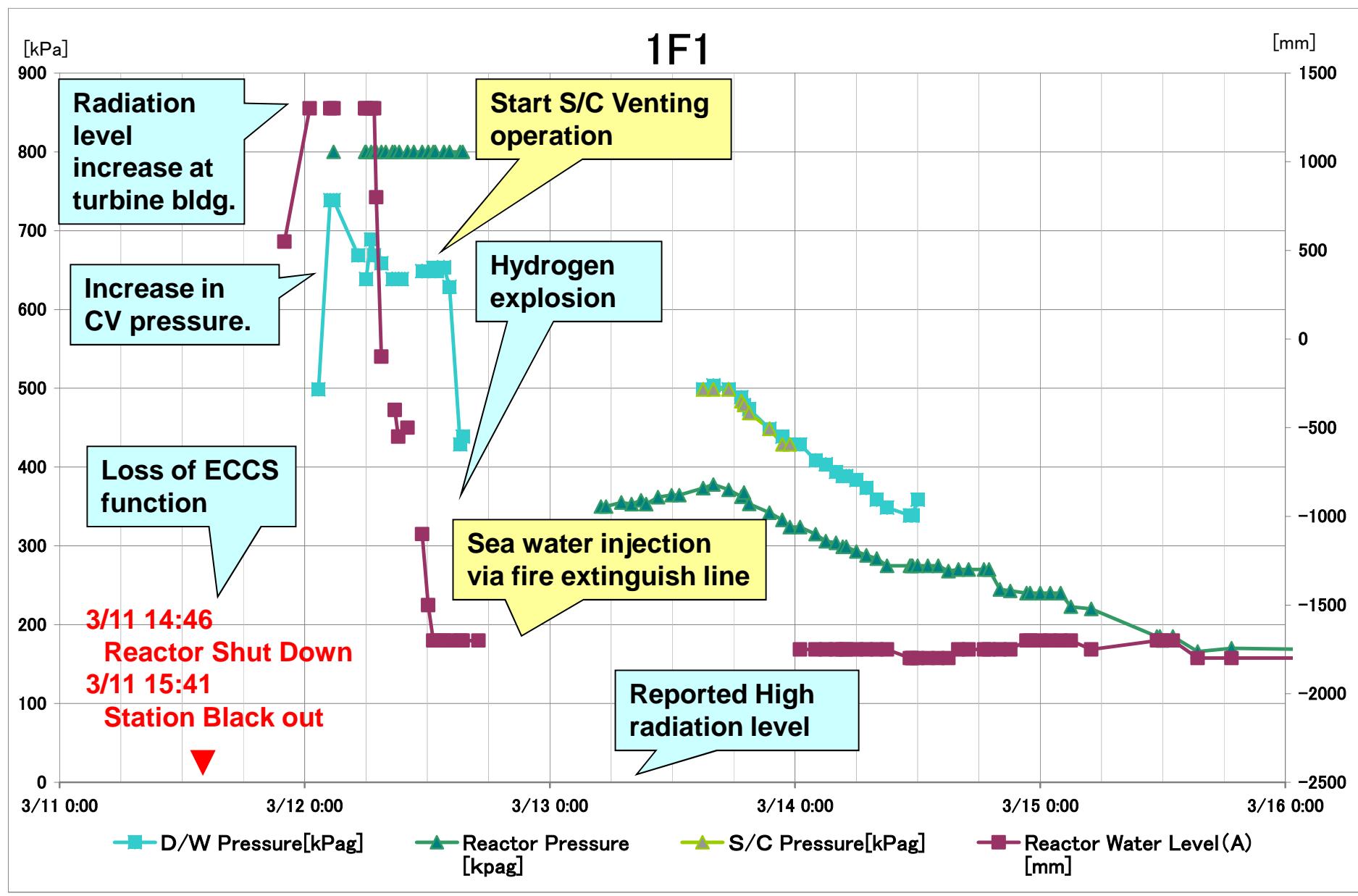
Source: Institute for Science and International Security (ISIS)

### 3-4. Chronology of Unit 1 after the earthquake

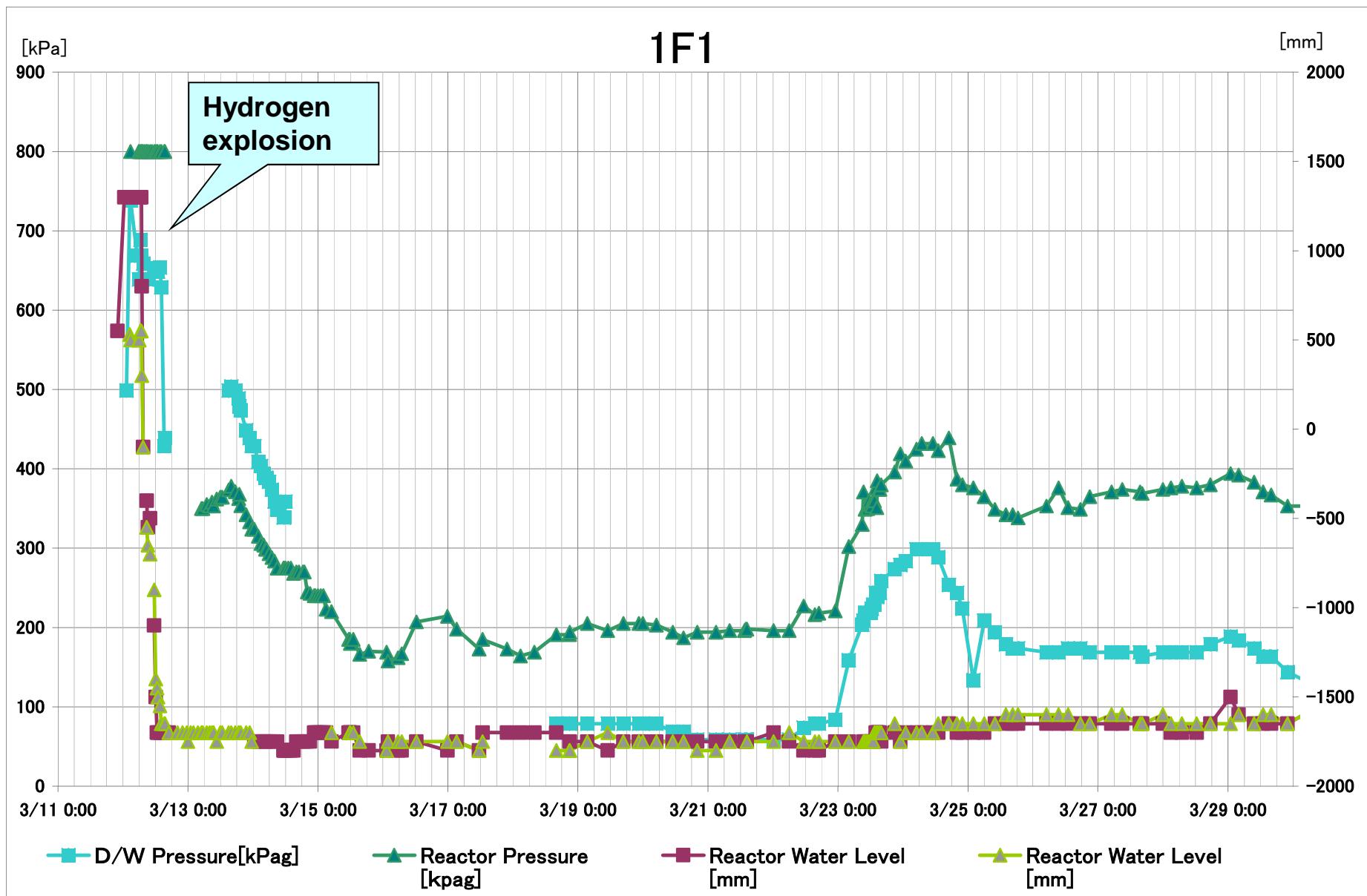
#### ● **Unit 1**

- 11<sup>th</sup>
  - Under operation, Automatic shutdown by the earthquake
  - Loss of A/C power
  - Loss of water injection function
- 12<sup>th</sup>
  - Unusual increase of PCV pressure
  - Started to vent
  - Sound of explosion
  - Started of injection of seawater and borated water to the core
- 22<sup>nd</sup>
  - Rise of reactor temperature (383°C) → Drop (26th 05:00 144.3°C)
- 23<sup>rd</sup>
  - Water supply line in addition to the Fire Extinguish line. Switched to water supply line only.(Flow rate: 7m<sup>3</sup>/h)
- 24<sup>th</sup>
  - Lighting in the Central Control Room was recovered.
- 25<sup>th</sup>
  - Started fresh water injection
- 29<sup>th</sup>
  - Switched to the water injection to the core using a temporary motor operated pump.
- 31<sup>st</sup>
  - White smoke was confirmed to generate continuously
  - Freshwater is being injected into the RPV

### 3-5. Trend data of Unit 1 until March 15

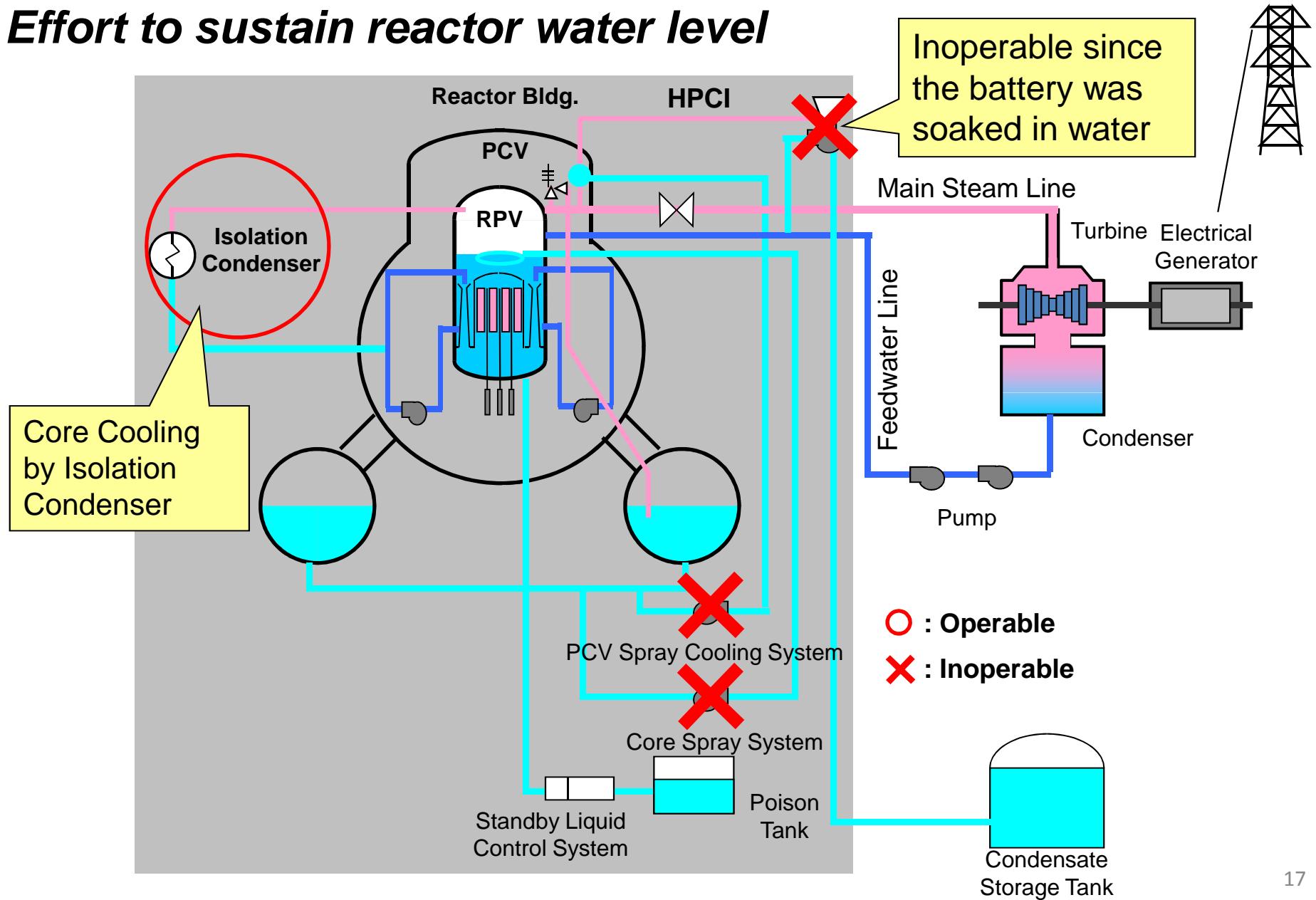


### 3-6. Trend data of Unit 1 until March 30



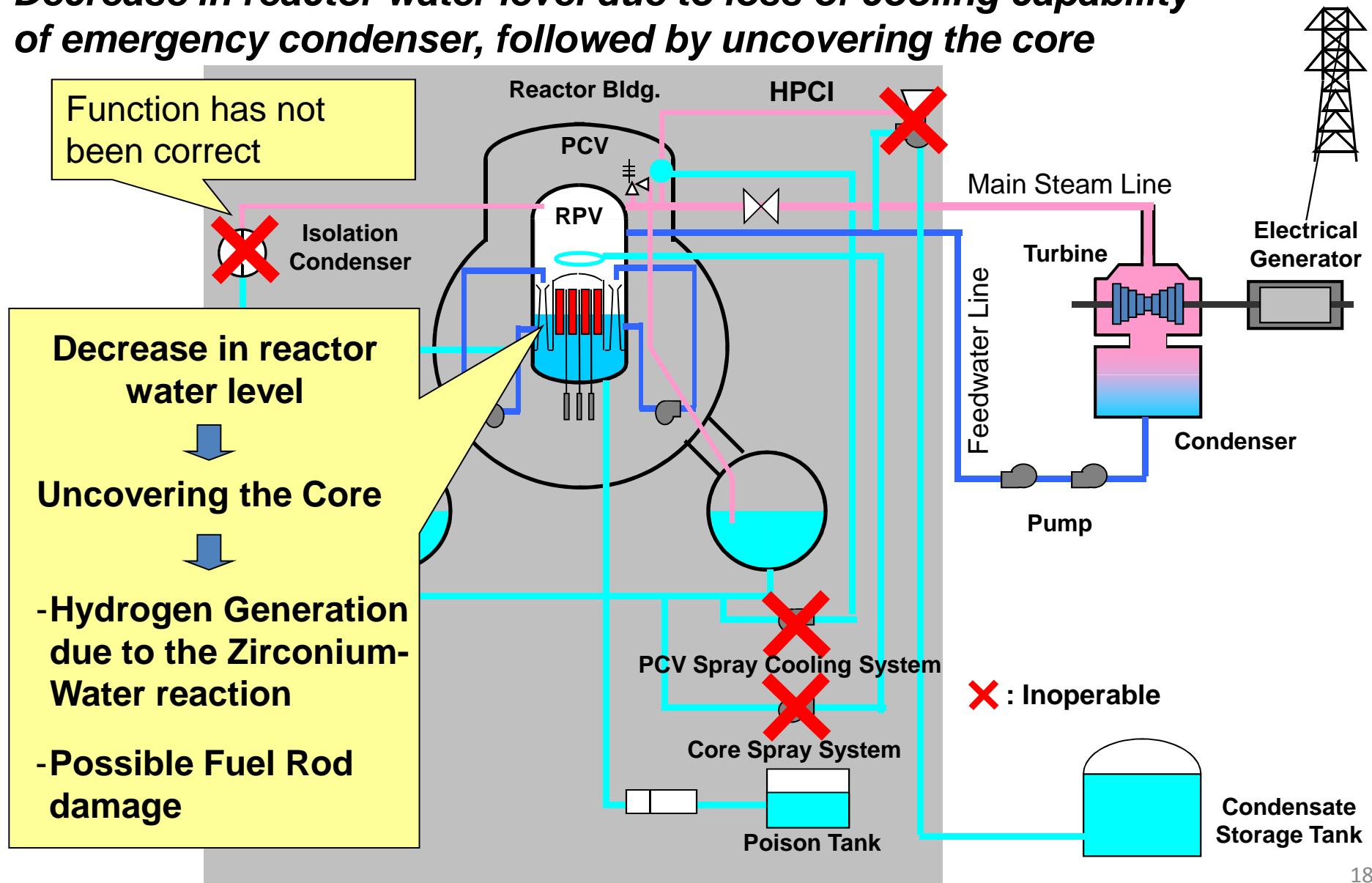
## 3-7. Major event progression at Unit 1 (1/4)

### ***Effort to sustain reactor water level***



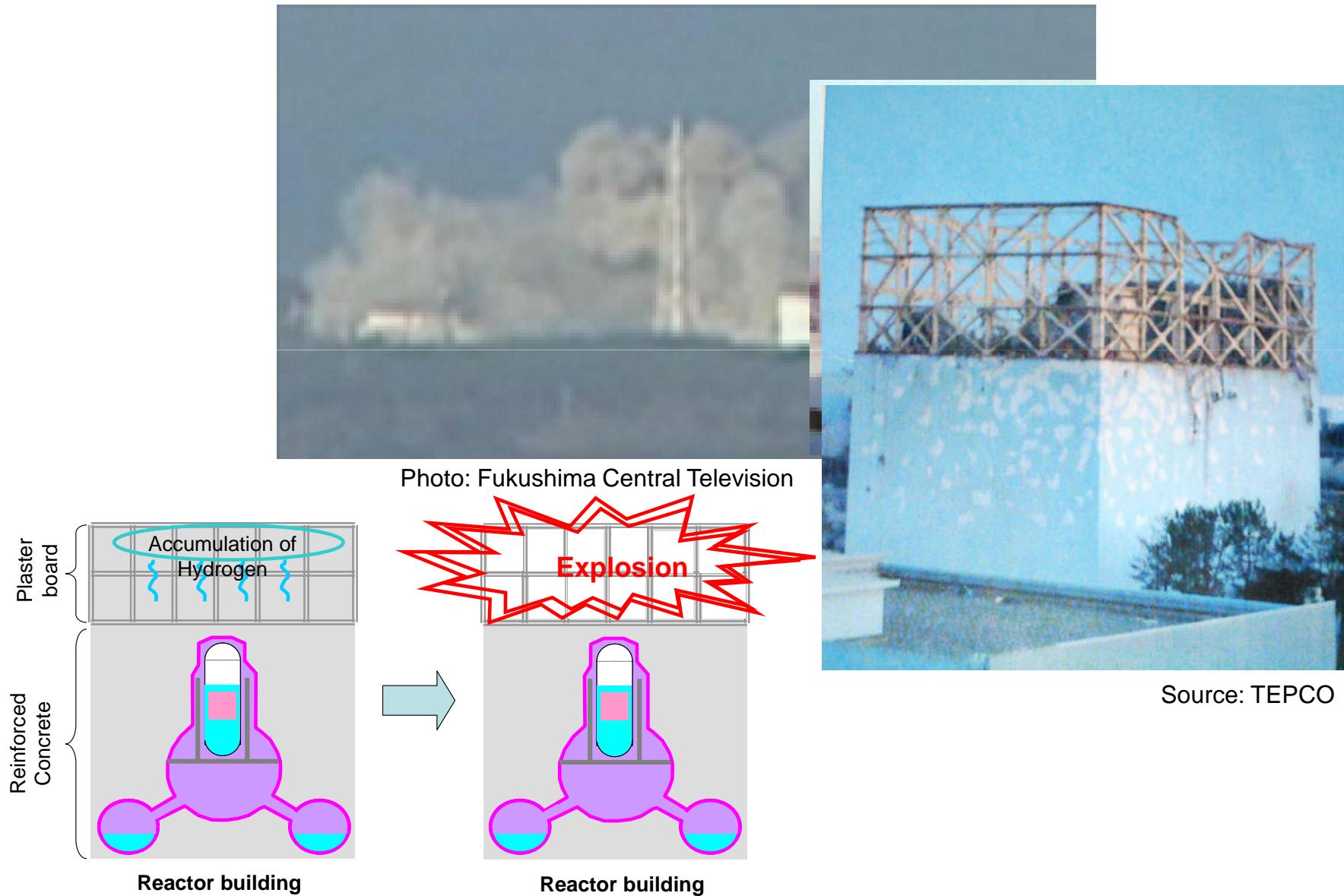
## 3-7. Major event progression at Unit 1 (2/4)

***Decrease in reactor water level due to loss of cooling capability of emergency condenser, followed by uncovering the core***



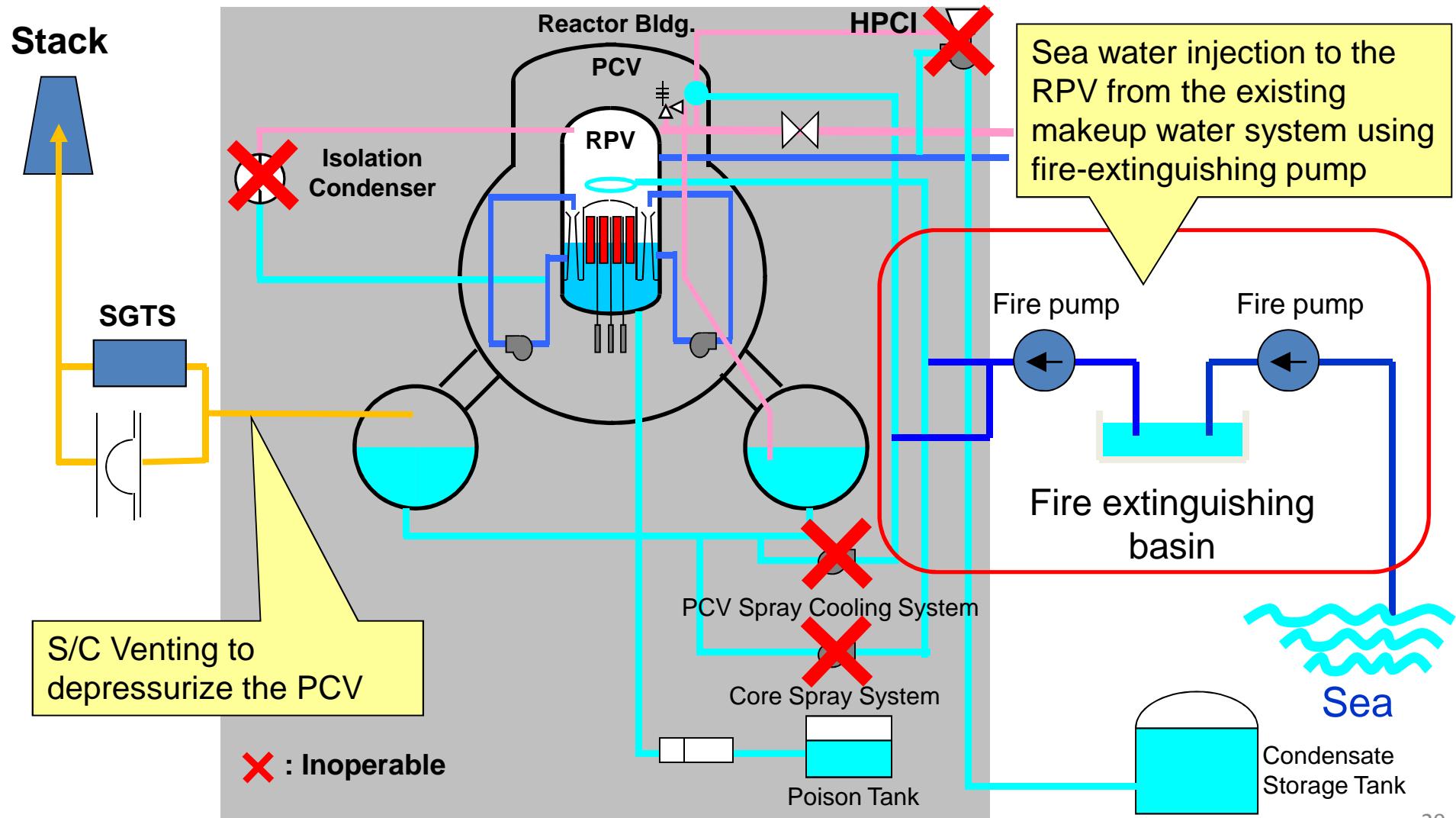
## 3-7. Major event progression at Unit 1 (3/4)

### ***Hydrogen explosion in the operation floor***

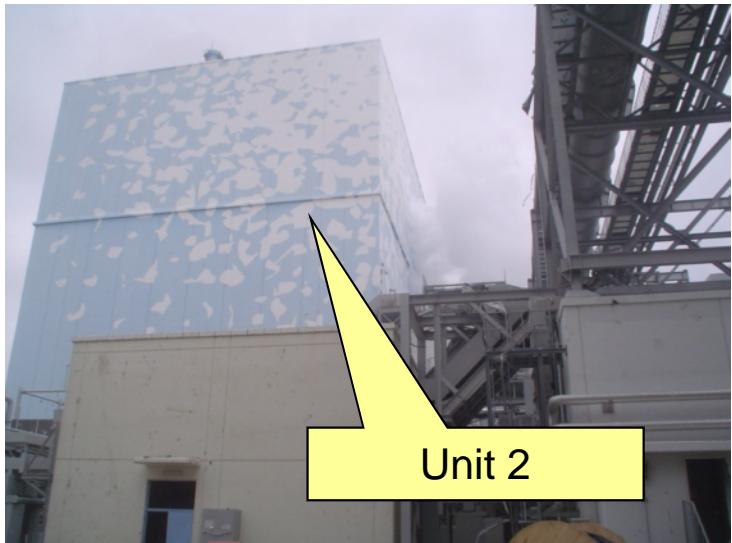


### 3-7. Major event progression at Unit 1 (4/4)

- Sea water injection using fire water pump
- S/C Venting to depressurize the PCV



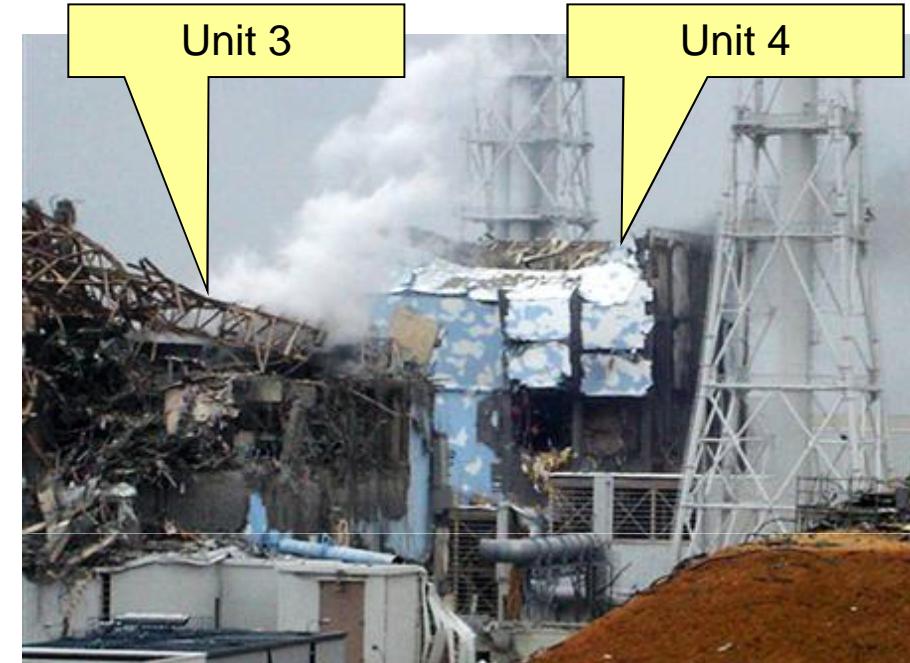
## 3-8. Accident Progression at Unit 2 through 4 reactors



Source: TEPCO



Photo: Fukushima Central Television



Source: TEPCO



Source: TEPCO

## 3-9. Chronology of Unit 2 after the earthquake (1/2)

### ● **Unit 2**

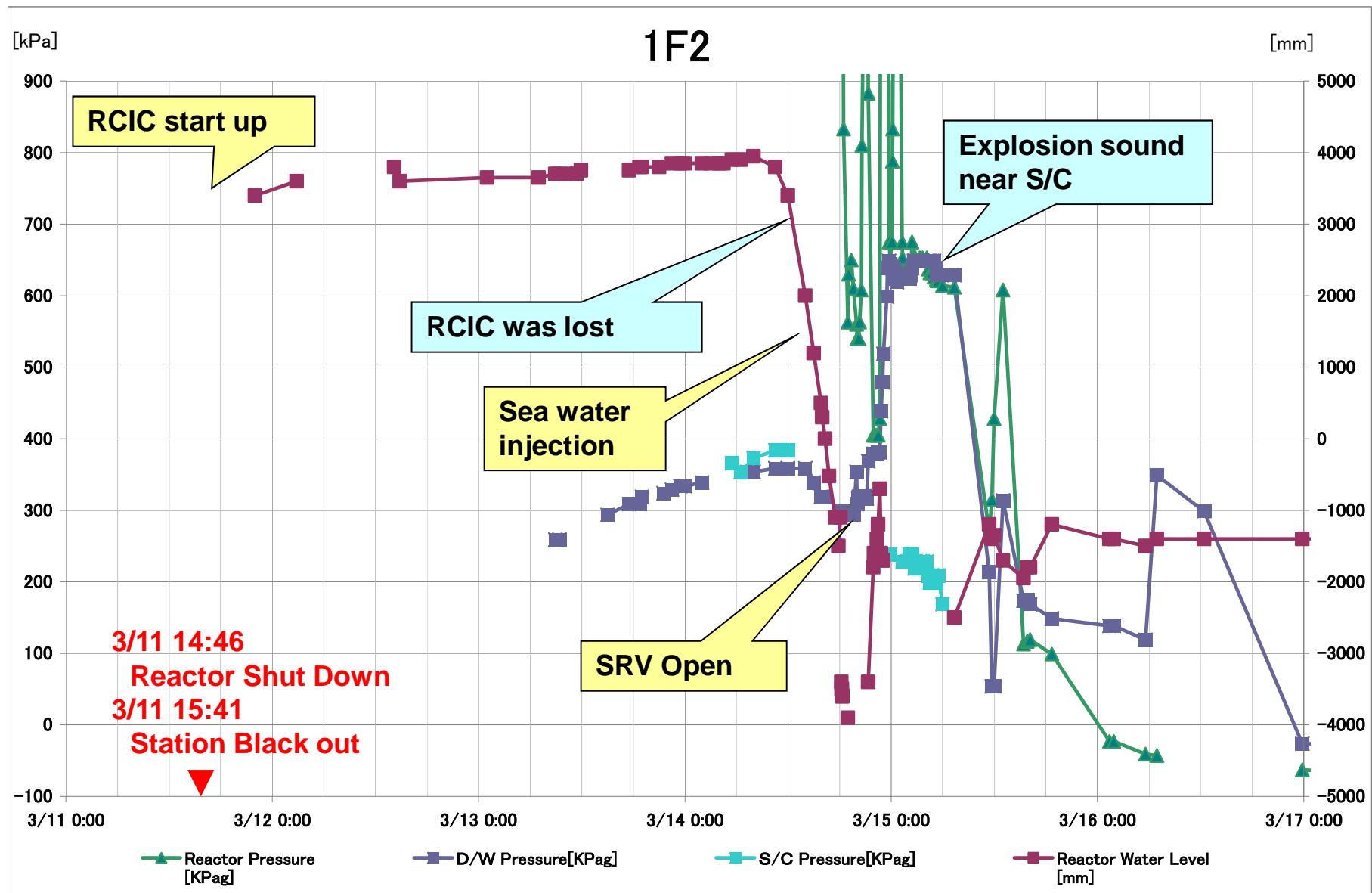
- 11<sup>th</sup>
  - Under operation, Automatic shutdown by the earthquake
  - Loss of A/C power
  - Loss of water injection function
- 14<sup>th</sup>
  - Loss of water cooling function
  - Unusual increase in PCV pressure
- 15<sup>th</sup>
  - Sound of explosion
  - Possible damage of the suppression chamber
- 20<sup>th</sup>
  - Injection of about 40 tons of seawater into SFP through fire extinguishing system.
  - Injection of seawater to the Spent Fuel Pool (SFP)
- 21<sup>st</sup>
  - White smoke generated
- 22<sup>nd</sup>
  - Injection of seawater to the Spent Fuel Pool (SFP)
- 25<sup>th</sup>
  - Injection of seawater to SFP

### 3-9. Chronology of Unit 2 after the earthquake (2/2)

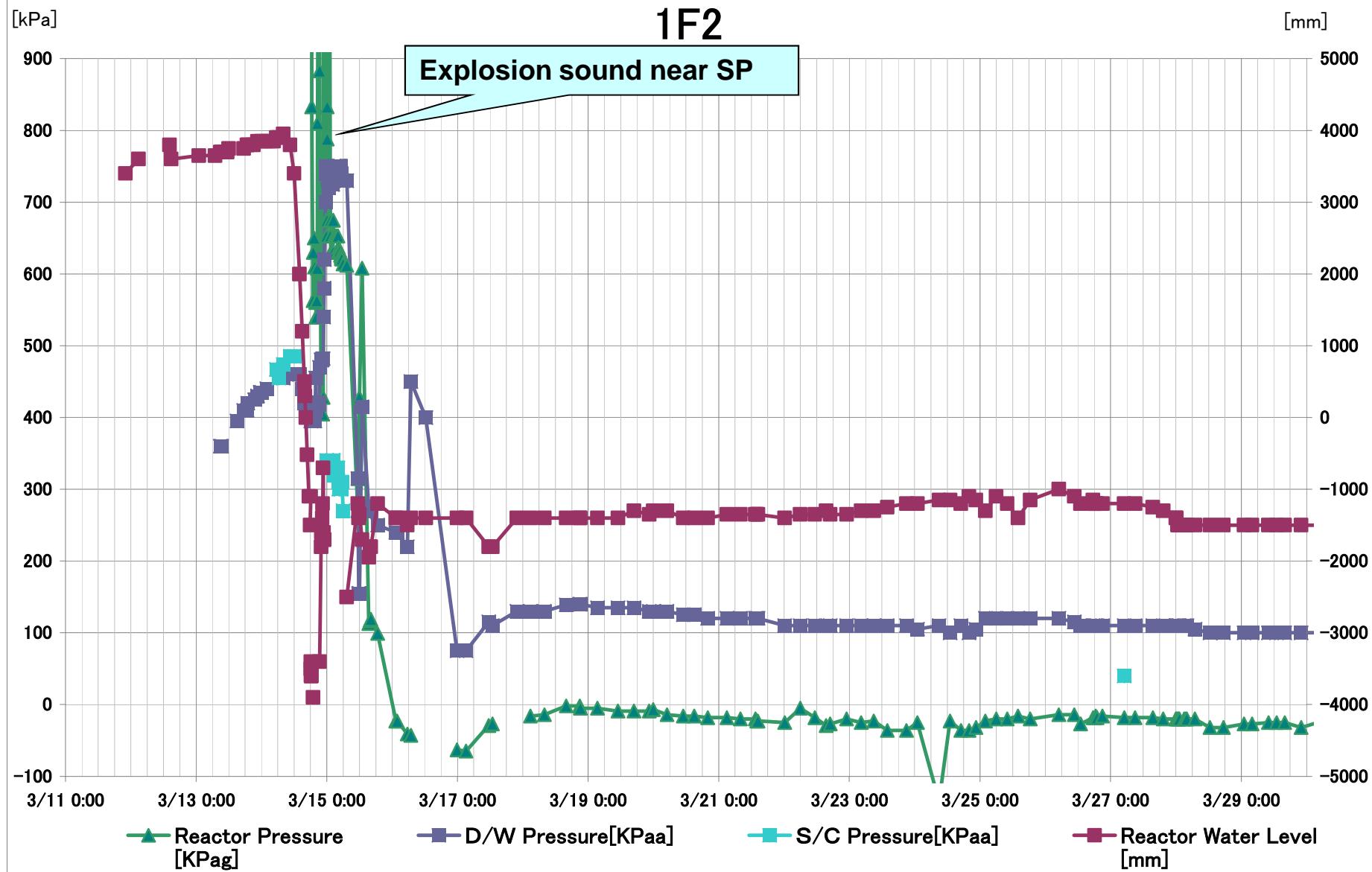
#### ● ***Unit 2(Continued)***

- 26<sup>th</sup> ●Lighting in the Central Control Room was recovered
- 27<sup>th</sup> ●Switched to the water injection to the core using a temporary motor-driven pump.
- 29<sup>th</sup> ●The Seawater injection to the Spent Fuel Pool using the Fire Pump Truck was switched to the fresh water injection using the temporary motor-driven pump  
●In order to prepare for transferring the stagnant water on the basement floor of turbine building to the Condenser, the water in the Condensate Storage Tank is being transferred to the Surge Tank of Suppression Pool Water.
- 30<sup>th</sup> ●The injection pump was switched to the Fire Pump Truck. However, because cracks were confirmed in the hose (12:47 and 13:10 March 30th), the injection was suspended. The injection of fresh water resumed at 19:05 March 30th.
- 31<sup>st</sup> ●White smoke was confirmed to generate continuously.  
●Fresh water is being injected to the spent fuel pool and the RPV

## 3-10. Trend data of Unit 2 until March 17



## 3-11. Trend data of Unit 2 until March 30



## 3-12. Chronology of Unit 3 after the earthquake (1/2)

### ● **Unit 3**

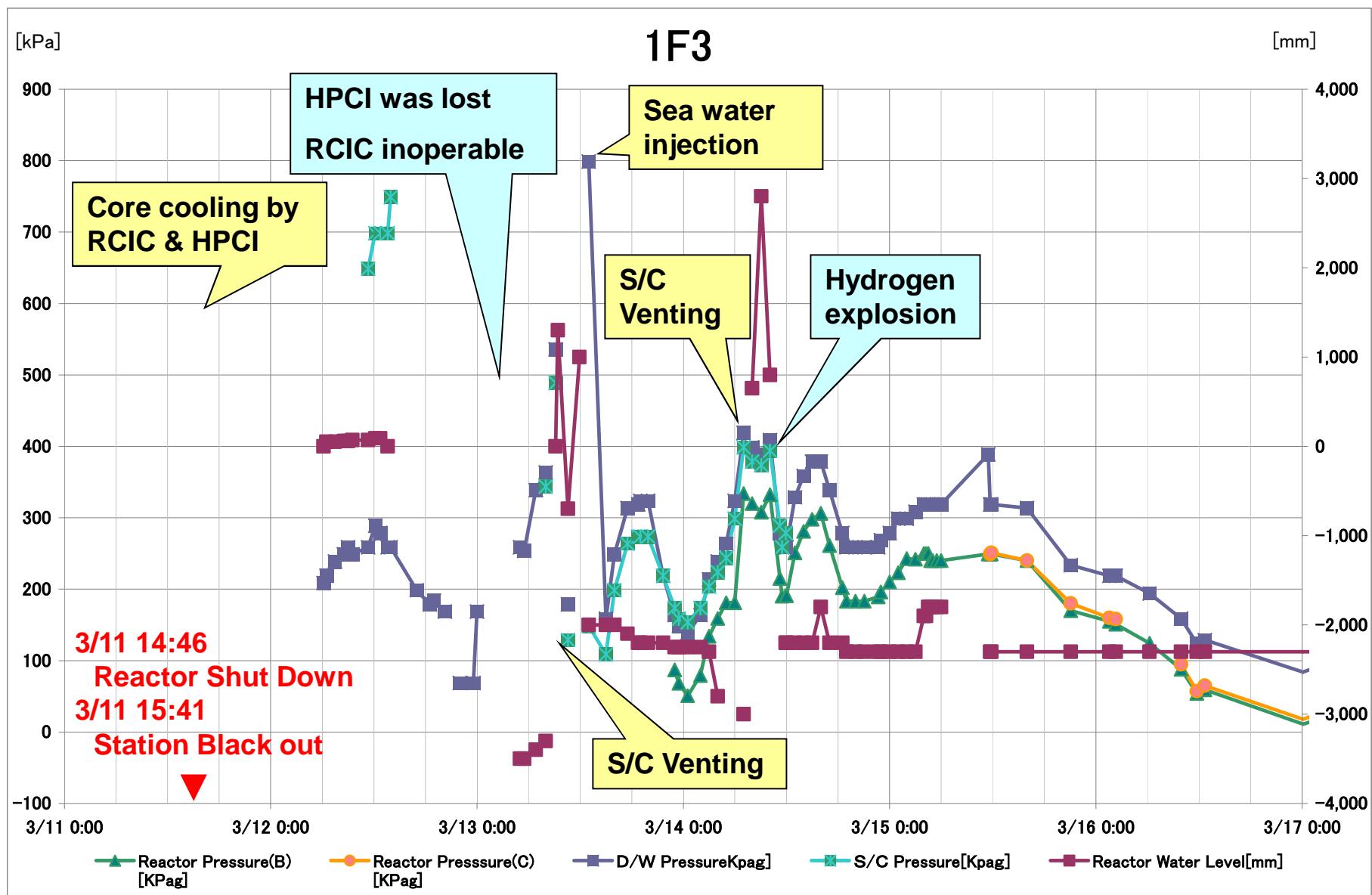
- 11<sup>th</sup>
  - Under operation, Automatic shutdown by the earthquake
  - Loss of A/C power
- 13<sup>th</sup>
  - Loss of water injection function
  - Started to vent
- 14<sup>th</sup>
  - Unusual increase in PCV pressure
  - Sound of explosion
- 16<sup>th</sup>
  - White smoke generated
- 17<sup>th</sup>
  - Water discharge by the helicopters of Self-Defense Force(4 times)
  - Water spray from the ground by High pressure water-cannon trucks  
(Police: once, Self-Defense Force: 5 times)
- 18<sup>th</sup>
  - Water spray from the ground by same trucks (Self-Defense Force: 6 times)
  - Water spray from the ground by US water-cannon trucks  
(US armed force: 1 time)
- 19<sup>th</sup>
  - Water spray from the ground by High pressure water-cannon trucks by  
Hyper Rescue Unit of Tokyo Fire Department.

## 3-12. Chronology of Unit 3 after the earthquake (2/2)

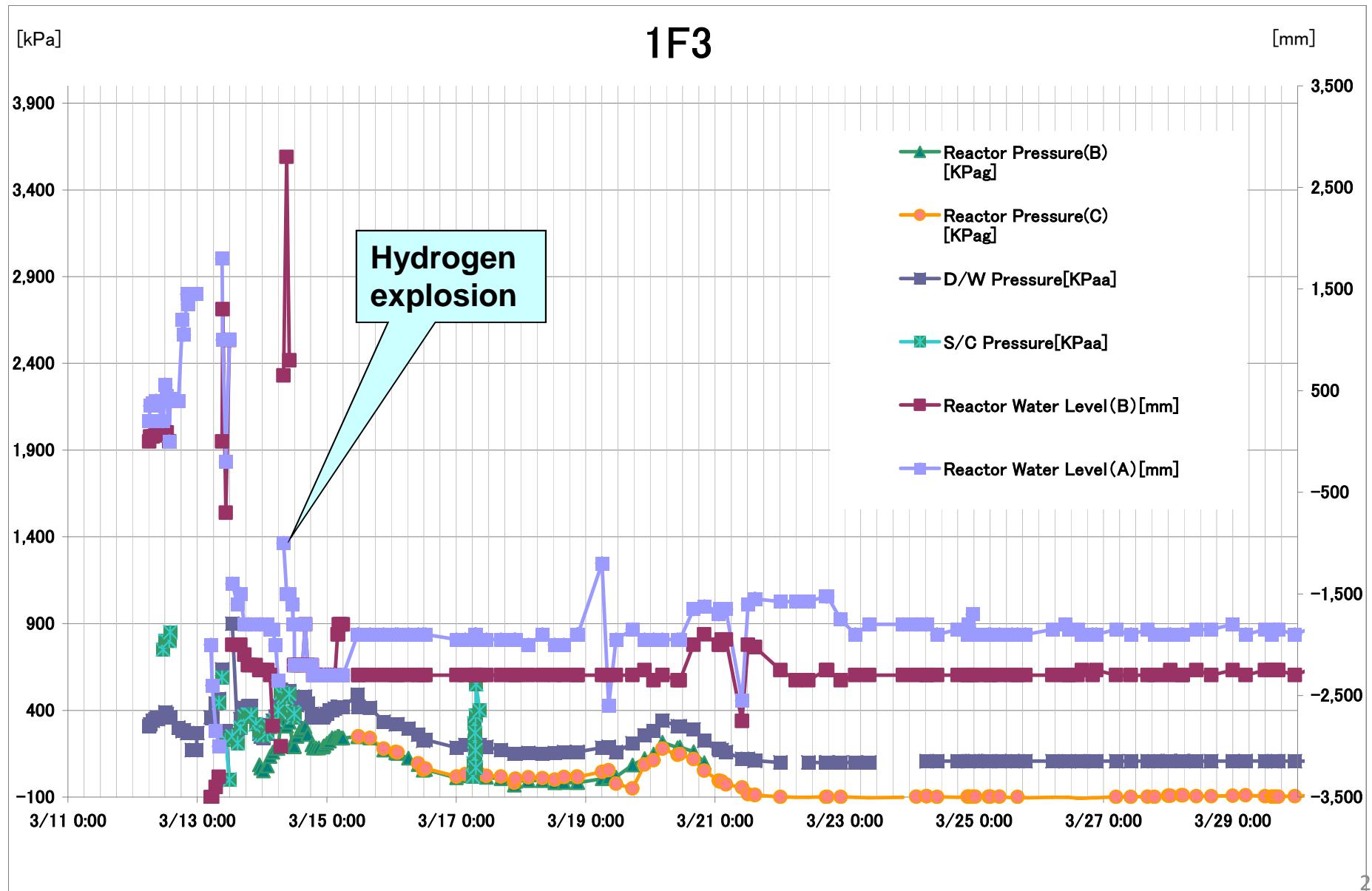
### ● ***Unit 3(Continued)***

- 20<sup>th</sup> ● Sprayed by Hyper Rescue Unit of Tokyo Fire Department
- 22<sup>nd</sup> ● Lighting in the Central Control Room was recovered.
- 23<sup>rd</sup> ● Injection of seawater to the SFP
- 24<sup>th</sup> ● Injection of seawater to the SFP
- 25<sup>th</sup> ● Water spray (Emergency fire support team)  
● Started fresh water injection
- 27<sup>th</sup> ● Water spray by Concrete Pump Truck
- 28<sup>th</sup> ● Switched to the water injection to the core using a temporary motor-driven pump  
● In order to prepare for transfer the stagnant water on the basement floor of turbine building to the Condenser, the water in the Condensate Storage Tank is being transferred to the Surge Tank of Suppression Pool Water
- 29<sup>th</sup> ● Started to spray freshwater by Concrete Pump Truck
- 31<sup>st</sup> ● White smoke was confirmed to generate continuously  
● Fresh water is being injected to the spent fuel pool and the RPV

### 3-13. Trend data of Unit 3 until March 17



## 3-14. Trend data of Unit 3 until March 30



### 3-15. Hydrogen explosion at Unit 1 & 3



Photo: Fukushima Central Television

**Unit 1**

**Unit 3**

## 3-16. Chronology of Unit 4 after the earthquake

### ● **Unit 4**

- 14<sup>th</sup>
  - Water temperature in the Spent Fuel Pool, 84°C
- 15<sup>th</sup>
  - Damage of wall in the 4<sup>th</sup> floor confirmed
  - Fire occurred in the 3<sup>rd</sup> floor (12:25 extinguished)
- 16<sup>th</sup>
  - Fire occurred. TEPCO couldn't confirm any fire on the ground.
- 20<sup>th</sup>
  - Water spray over the spent fuel pool by Self Defense Force
- 21<sup>st</sup>
  - Water spray over the spent fuel pool by Self Defense Force
- 22<sup>nd</sup>-24<sup>th</sup>
  - Water spray (Concrete Pump Track (3 times))
- 25<sup>th</sup>
  - Injection of seawater to SFP via the Fuel Pool Cooling Line (FPC)
  - Water spray (Concrete Pump Truck)
- 27<sup>th</sup>
  - Water spray (Concrete Pump Truck)
- 29<sup>th</sup>
  - Lighting in the Central Control Room was recovered.
- 30th
  - White smoke was confirmed to generate continuously.
  - Spray of fresh water (Around 140t) over the Spent Fuel Pool using Concrete Pump Truck (50t/h) was carried out.
  - Fresh water is being injected to the spent fuel pool

## 3-17. Chronology of Unit 5 & 6 after the earthquake

### ● ***Unit 5&6***

- 20<sup>th</sup>
  - Unit 5 under cold shutdown (Water temperature of reactor water is less than 100°C)
  - Unit 6 under cold shutdown (Water temperature of reactor water is less than 100°C)
- 21<sup>st</sup>
  - Water spray over the Common Spent Fuel Pool started
- 22<sup>nd</sup>
  - Recovering power supply of unit 5 and 6 is completed.
- 24<sup>th</sup>
  - The power was started to be supplied. Cooling also started
- 30<sup>th</sup>
  - Bach up power of Unit 6 is in working condition and external power was supplied to Unit 5 as of March 30<sup>th</sup>

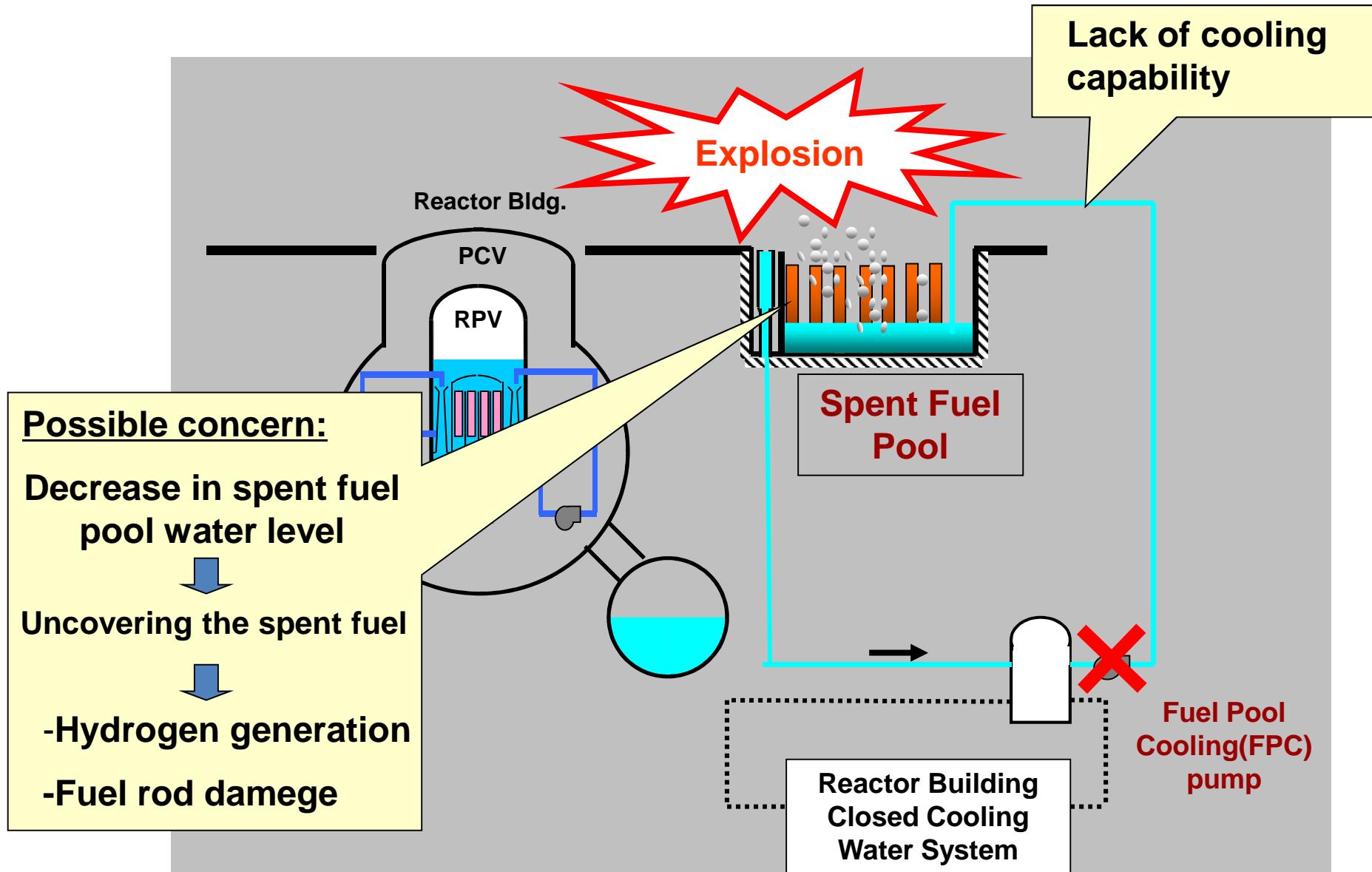
#### 4. Report concerning incidents at spent fuel pools in the Fukushima Dai-ichi NPS



Source: TEPCO

**Photo: Water spray into the SFP in Unit 4 using concrete pump truck**

## 4-1. Possible concerns about Spent Fuel Pool



## 4-2. Status of the Fuel as of March 11, 2011

Unit	1	2	3	4	5	6
Number of Fuel Assembly in the Core	400	548	548	-	548	764
Number of Spent Fuel Assembly in the Spent Fuel Pool	292	587	514	1,331	946	876
Number of New Fuel Assembly in the Spent Fuel Pool	100	28	52	204	48	64
Water Volume (m <sup>3</sup> )	1,020	1,425	1,425	1,425	1,425	1,497

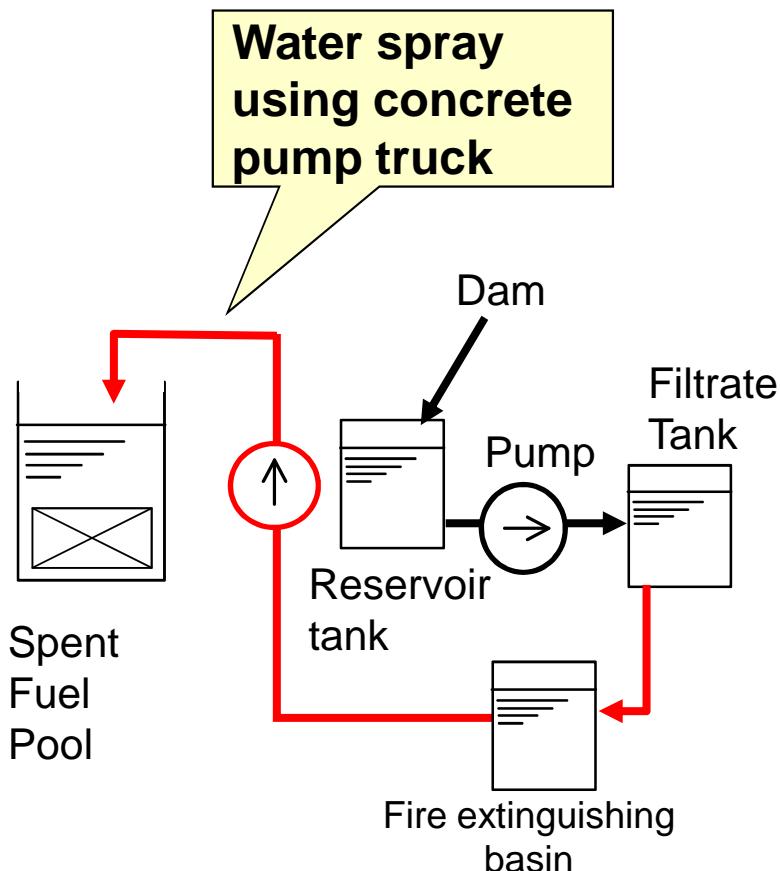
### Condition of the fuel in the Spent Fuel Pool

Unit 1	Unit 2	Unit 3	Unit 4
-Most recent shut down was on Sep.27,2010	- Most recent shut down was on Nov.18,2010	- Most recent shut down was on Sep.23,2010	-Most recent shut down was on Nov.29,2010 -All fuel assembly was removed from the core and located in the pool due to the core shroud replacement

## 4-3. Measures taken to cool the Spent Fuel Pool (1/4)

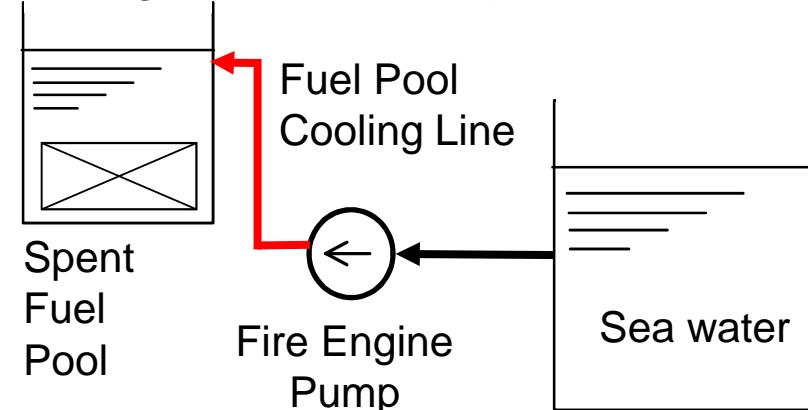
### Unit 1

Fresh water injection

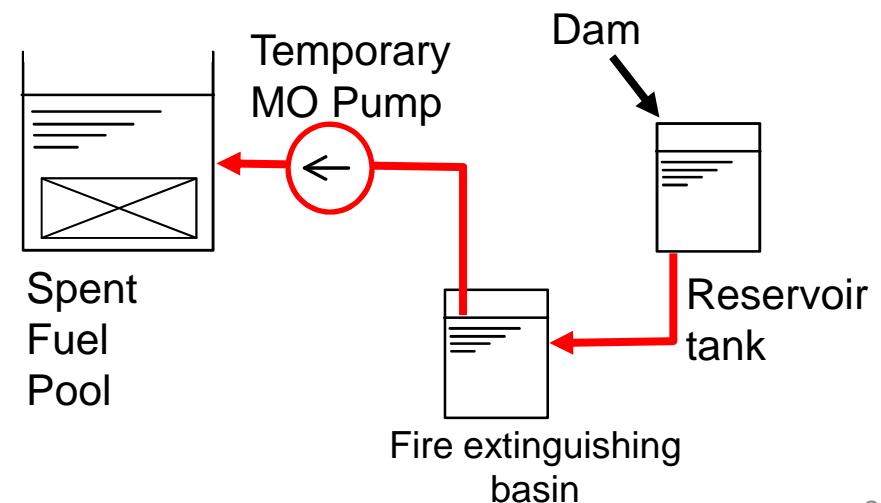


### Unit 2

【1st Stage】 Sea water injection



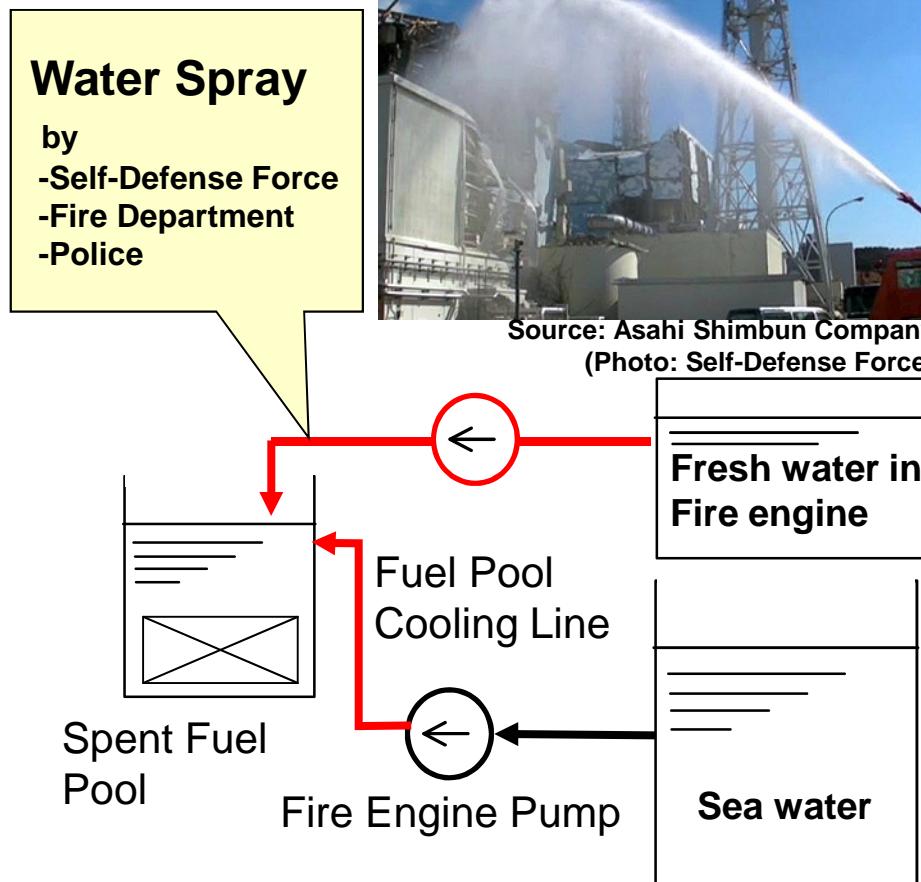
【2nd Stage】 Fresh water injection



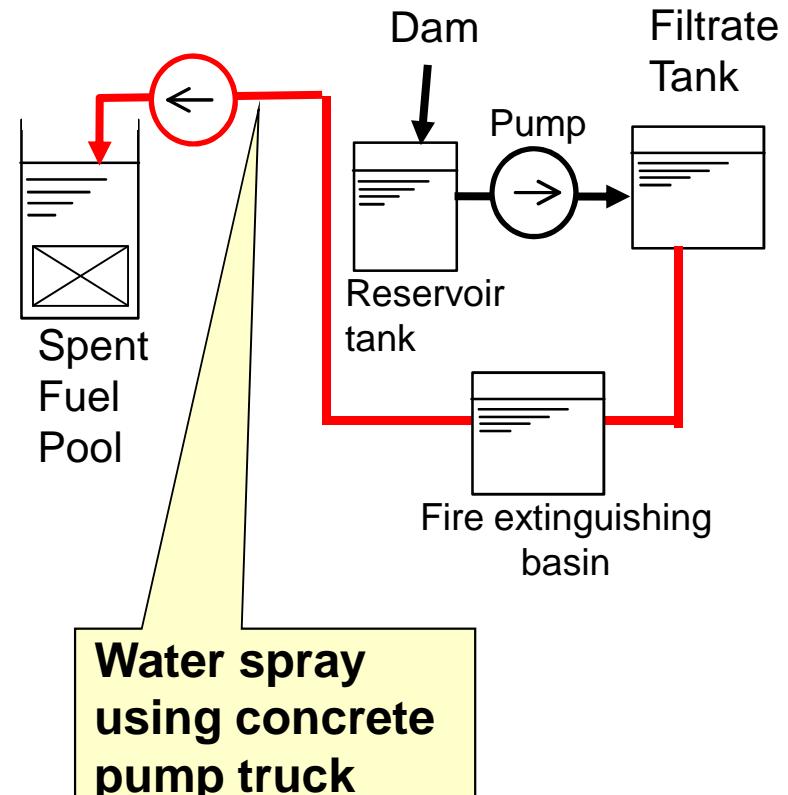
## 4-3. Measures taken to cool the Spent Fuel Pool (2/4)

### Unit 3

#### 【1st Stage】 Sea water injection



#### 【2nd Stage】 Fresh water injection

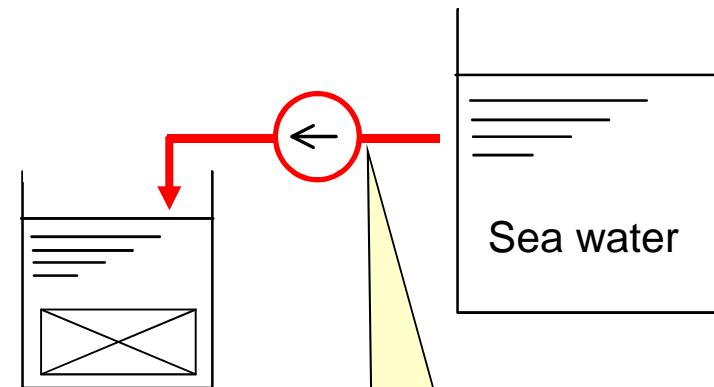


\* Sea water discharge by helicopters  
of the Self Defense Force

## 4-3. Measures taken to cool the Spent Fuel Pool (3/4)

### Unit 4

【1st Stage】 Sea water injection

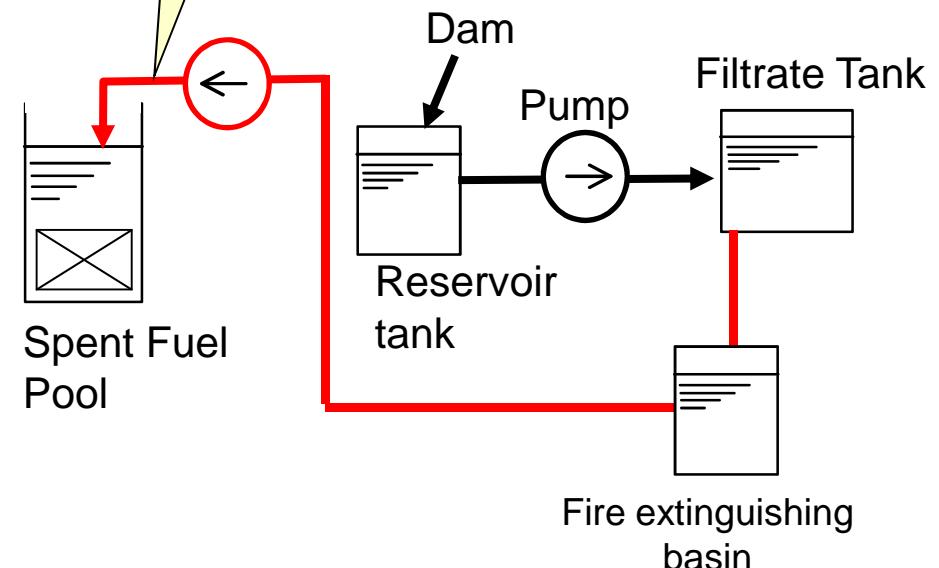


Spent Fuel  
Pool

**Water Spray from  
the ground by Self  
Defense Force and  
Fire Department**

【2nd Stage】 Fresh water injection

**Water spray  
using concrete  
pump truck**



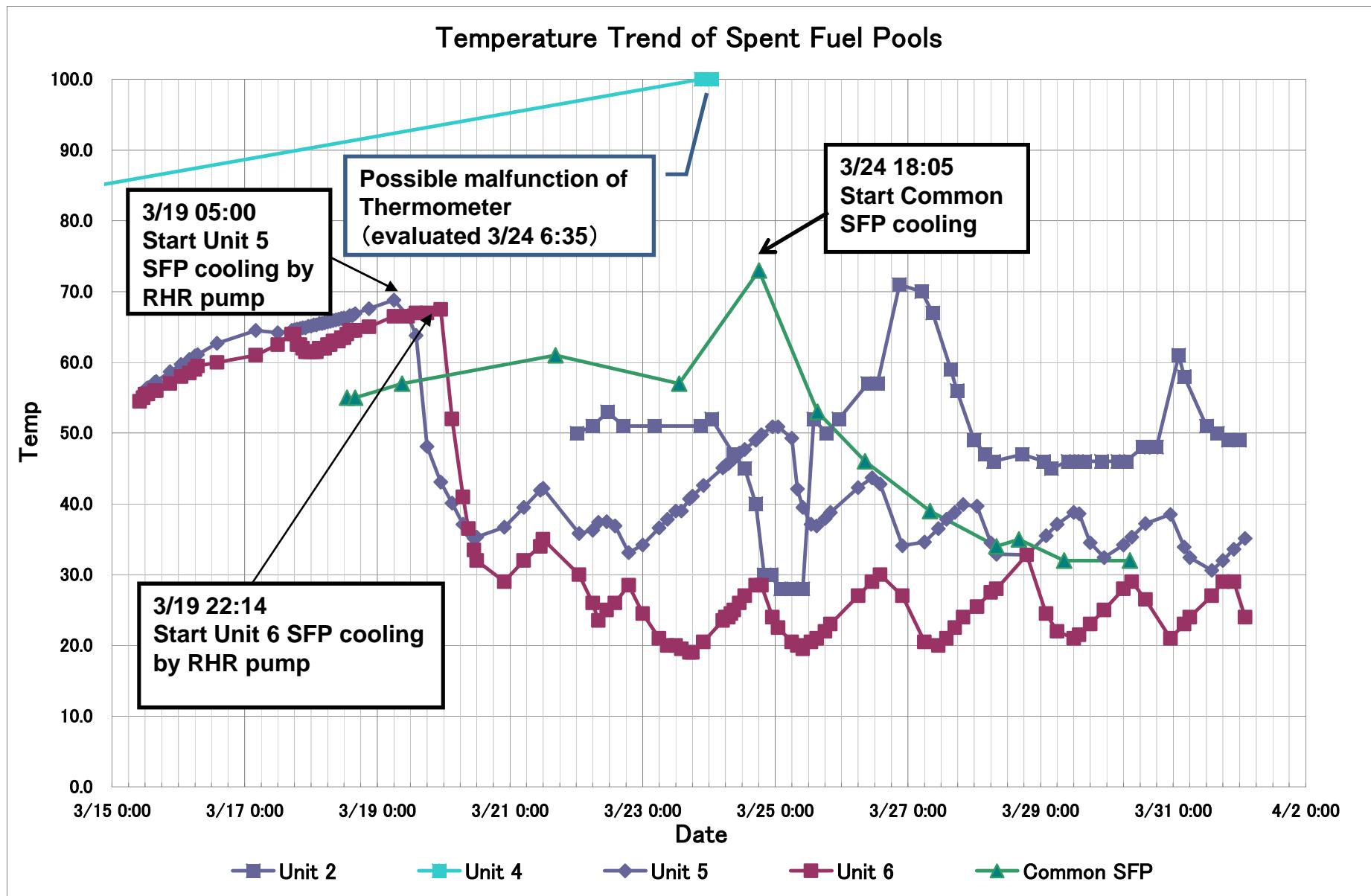
Dam

Filtrate Tank

Reservoir  
tank

Fire extinguishing  
basin

## 4-3. Measures taken to cool the Spent Fuel Pool (4/4)



## 4-4. INES Rating

- NISA issued temporary INES ratings 3 times. Those provisional ratings are provided based on “What is known” at the time.
- The first temporary rating was issued at 0:30 on March 12 (About 10 hours later from the earthquake attack)  
At that moment, Following units were rated as Level 3 since all heat removal function became inoperable based on “Defense in Depth” criteria.
  - Fukushima dai-ichi unit 1, 2 and 3
  - Fukushima dai-ni Unit 1, 2 and 4
- In the evening on March 12, the rating of Fukushima dai-ichi Unit 1 was re-evaluated to Level 4 base on the “Radiological Barriers and Control” criteria, since the radiation level in the site increased.
- On March 18, re-evaluation was carried out. The rating of Fukushima dai-ichi Unit 1, 2 and 3 were re-rated to Level 5 based on “Radiological Barriers and Control” criteria because the fuel damage was highly possible. Fukushima dai-ichi Unit 4 was evaluated to Level 3 based on the “Defense in Depth” criteria.

## **5. Action taken by the government**

## 5. Action Taken by the Government(1/5)

**March 11<sup>th</sup>, 2011**

- 14:46 ● Set up of the NISA Emergency Preparedness Headquarters (Tokyo) immediately after the earthquake
- 19:03 ● Government declared the state of nuclear emergency. (Establishment of Government Nuclear Emergency Response Headquarters and Local Emergency Response Headquarters)
- 21:23 ● Directives from Prime Minister to the Governor of Fukushima Prefecture and heads of towns were issued regarding the event occurred at Fukushima Daiichi NPS, TEPCO, in accordance with the Act on Special Measures Concerning Nuclear Emergency Preparedness as follows:
  - Direction for the residents within 3km radius from Unit 1 to evacuate
  - Direction for the residents within 10km radius from Unit 1 to stay in-house
- 24:00 ● Vice Minister of Economy, Trade and Industry, Ikeda arrived at the Local Emergency Response Headquarters

## 5. Action Taken by the Government(2/5)

**March 12<sup>nd</sup>, 2011**

- 05:44 ●Residents within 10km radius from Unit 1 of Fukushima Dai-ichi NPS shall evacuate by the Prime Minister Direction
- 07:45 ●Directives from Prime Minister to the Governor of Fukushima Prefecture and heads of towns were issued regarding the event occurred at Fukushima Dai-ni NPS, TEPCO, pursuant to Act on Special Measures Concerning Nuclear Emergency Preparedness as follows:
  - Direction for the residents within 3km radius from Fukushima Dai-ni NPS to evacuate
  - Direction for the residents within 10km radius from Fukushima Dai-ni NPS to stay in-house
- 17:39 ●Prime Minister directed evacuation of the residents within the 10 km radius from Fukushima-Dai-ni NPS
- 18:25 ●Prime Minister directed evacuation of the residents within the 20km radius from Fukushima Dai-ichi NPS
- 20:05 ●Considering the Directives from Prime Minister and pursuant to the Nuclear Regulation Act, the order was issued to inject seawater to Unit 1 of Fukushima Dai-ichi NPS and so on.

## 5. Action Taken by the Government(3/5)

### March 13<sup>th</sup>, 2011

- 09:30 ● Directive was issued for the Governor of Fukushima Prefecture and heads of towns in accordance with the Act on Special Measures Concerning Nuclear Emergency Preparedness on the contents of radioactivity decontamination screening.

### March 15<sup>th</sup>, 2011

- 05:30 ● Prime Minister, Kan expressed to establish The Joint Headquarters to Fukushima Dai-ichi NPS accident
- 10:30 ● According to the Nuclear Regulation Act, Minister of Economy, Trade and Industry issued the directions as follows.  
-For Unit 4: To extinguish fire and to prevent the occurrence of re-criticality  
-For Unit 2: To inject water to reactor vessel promptly and to vent Drywell
- 11:00 ● Prime Minister directed the in-house stay area. -In-house stay was additionally directed to the residents in the area from 20 km to 30 km radius from Fukushima Dai-ichi NPS considering reactor situation
- 22:00 ● According to the Nuclear Regulation Act, Minister of Economy, Trade and Industry issued the following direction.  
- For Unit 4: To implement the injection of water to the Spent Fuel Pool.

### March 20<sup>th</sup>, 2011

- 23:30 ● Directive from Local Emergency Response Headquarters to the Prefectural Governor and the heads of cities, towns and villages was issued regarding the change of the reference value for the screening level for decontamination of radioactivity

## 5. Action Taken by the Government(4/5)

### March 21<sup>st</sup>, 2011

- 07:45 ● Directive titled as “Administration of the stable Iodine” was issued from Local Emergency Response Headquarters to the Prefectural Governor and the heads of cities, towns and villages.
- 16:45 ● Directive titled as “Ventilation for using heating equipments within the in-house evacuation zone” was issued from the Head of Local Emergency Response Headquarters to the Prefectural Governor and the heads of cities, towns and villages.
- 17:50 ● Directive from the Head of Government Nuclear Emergency Response Headquarters to the Prefectural Governors of Fukushima, Ibaraki, Tochigi and Gunma was issued, which directs the above-mentioned governors to issue a request to relevant businesses and people to suspend shipment of spinach, Kakina (a green vegetable) and raw milk for the time being.

### March 25<sup>th</sup>, 2011

- NISA directed orally to the TEPCO regarding the exposure of workers at the turbine building of Unit 3 of Fukushima Dai-ichi Nuclear Power Station occurred on March 24th, to review immediately and to improve its radiation control measures from the viewpoint of preventing a recurrence.

## 5. Action Taken by the Government(5/5)

### March 25<sup>th</sup>, 2011

- Since there was a mistake in the evaluation regarding the concentration measurement of radioactive materials, NISA directed TEPCO orally to prevent the recurrence of such a mistake
- 13:50    ● Receiving the suggestion by the special meeting of Nuclear Safety Commission, NISA directed TEPCO orally to add the sea water monitoring points and carry out the groundwater monitoring.
- Regarding the delay in the reporting of the water confirmed outside of the turbine buildings, NISA directed TEPCO to accomplish the communication in the company on significant information in a timely manner and to report it in a timely and appropriate manner.

### March 29th, 2011

- In order to strengthen the system to assist the nuclear accident sufferers, the “Team to Assist the Lives of the Nuclear Accident Sufferer” headed by the Minister of Economy, Trade and Industry was established

### March 30th, 2011

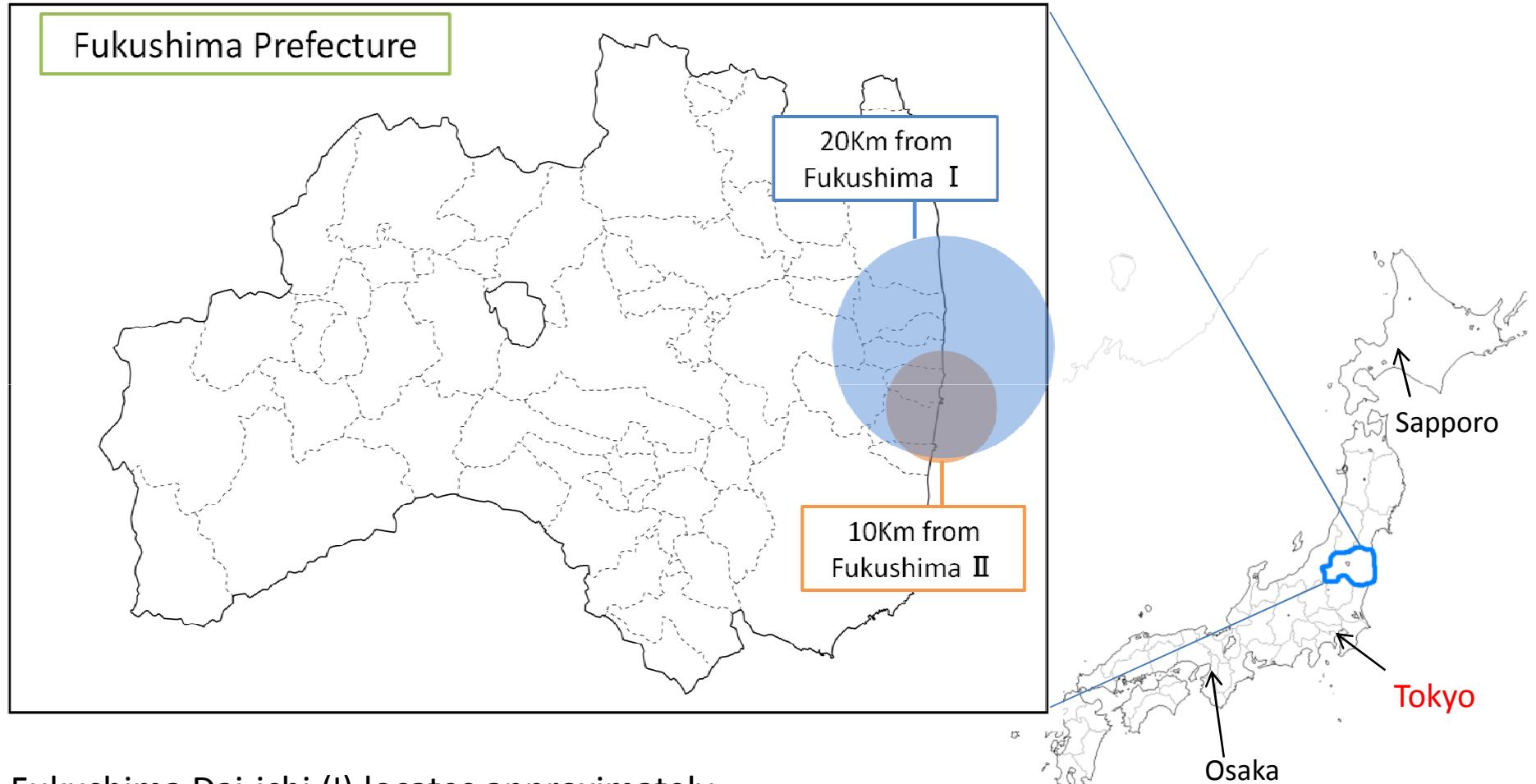
- Directions as to implement the emergency safety measures for the other power stations considering the accident of Fukushima Dai-ichi and Dai-ni NPSs in 2011 was issued and handed to each electric power company and the relevant organization.

## **6. Current situation on resident evacuation and radiation exposure, etc**

## 6-1. Current Situation on Resident Evacuation(1/2)

- At 5:44 on March 12, residents within 10km radius from Unit1 of Fukushima Dai-ichi NPS shall evacuate by the Prime Minister Directive.
- At 18:25 on March 12, Prime Minister directed evacuation of the residents within the 20 km radius from Fukushima Dai-ichi NPS.
- On March 15th, the Local Emergency Response Headquarter issued “the direction to administer the stable Iodine during evacuation from the evacuation area (20 km radius)” to the Prefecture Governors and the heads of cities, towns and villages.
- Regarding the evacuation as far as 20 km from Fukushima Dai-ichi NPS and 10 km from Fukushima Dai-ni NPS, necessary measures have already been taken.
  - The sheltering stay in the area from 20km to 30km from Fukushima Dai-ichi NPS is made fully known to the residents concerned.
  - Cooperating with Fukushima Prefecture, livelihood support to the residents in the sheltering area are implemented.
- On March 25th, Chief Cabinet Secretary, Edano promoted voluntary evacuations for the residents within the area from 20 km to 30 km from Fukushima Dai-ichi NPS in a press conference.

## 6-1. Current Situation on Resident Evacuation(2/2)



Fukushima Dai-ichi (I) locates approximately

- 230 km from Tokyo
- 580 km from Osaka
- 600 km from Sapporo

## 6-2. Major Possibility on radiation exposure to residents (As of 15:30 April 1st)

- 95 patients of Futaba Welfare Hospital transferred by JSDF helicopters and commercial buses. If explosion occurred while 60 patients to be transferred by JSDF helicopters were standing by on Futaba High School playground. No exposure suspected. (19:00, March 16)
- Screening started at Off-site Center on Sat. March 12. 162 screened as of March 15. Against initially-set decontamination threshold of 6,000cpm, 110 patients registered below the threshold, 41 above it. Of 162 screened patients, 5 were given decontamination measures and transferred to hospital.
- Fukushima Prefecture conducted screening at 4 locations in the prefecture. Some 30 people registered above 13,000cpm. After measuring for the second time following decontamination they showed low values, therefore they were returned to shelters without examination.
- 3 women who lived around 10km radius of Fukushima Dai-ichi until March 14 were examined at Iwate Medical University Hospital. Simple decontamination procedure was given without surveying. They were hospitalized for follow-up.

## 6-3.Major exposure of workers(As of 15:30 April 1st)

- To date a total of 21 people have registered exposure dose above 100mSv. Following measures were taken.
  - 17 people had facial contamination on March 12 (9 TEPCO employees, 8 support company employees). Exposure identified upon their measurement after returning from Controlled Area. However, the level of exposure would not affect their health.
  - At the time of ventilation operation at Unit 1 on March 12, one TEPCO employee registered above 100mSv (106.30mSv/h). As the level was below acute exposure he conducted work after self-air setting. As he afterwards complained of headache and other symptoms, he was transferred to hospital and placed at rest. He now has returned home.
  - On March 24, dosage above approx. 170mSv was confirmed on 3 workers who were laying cables on 1st floor and basement of Unit 3 Turbine Bldg. Attachment of radioactive substances on the skin of both legs was confirmed on two of them. Examination showed that none of the 3 had any major systemic risk. Exposure dose on the legs of the 2 was estimated to be 2～3Sv. While the level of leg and internal exposure did not require treatment, they were hospitalized. They were discharged on March 28.
- On April 1st, a worker fell into the sea when he got into a barge of US. He was rescued by workers, and was not injured etc. However, he was confirmed surface contamination and decontaminated by the shower. He was confirmed the non-contamination by nasal smears.

## 6-4. Major Situation of the injured (As of 15:00 April 3rd)

### <Death due to earthquake(Found on March 30)>

- Two employees found in the turbine building of Unit 4)

### <Injury due to earthquake(March11)>

- Two employees (slightly)
- Two subcontract employees (one fracture in both legs)

### <Injury due to the explosion of Unit 1 of Fukushima Dai-ichi NPS(March12)>

- Four employees were injured at the explosion and smoke of Unit 1 around turbine building (non-controlled area of radiation) and were examined by Kawauchi Clinic.

### <Injury due to the explosion of Unit 3 of Fukushima Dai-ichi NPS(March14)>

- Four TEPCO's employees
- Three subcontractor employees
- Four members of Self-Defence Force (The member was discharged from the institute on March 17th.)

### <Other injuries>

- Two subcontractor's employees were injured during working at temporary control panel of power source in the Common Spent Fuel Pool(March22,23)

## 6-5. Directive regarding foods and drinks

### (1) Agricultural Goods

- Ministry of Health, Labor and Welfare (MHLW) set provisional regulatory standards for foods detected with radioactive substances and notified prefectures, etc. as “Handling of food contaminated by radioactivity”.
- MHLW notified prefectures, etc. regarding points to be mindful of in examining foods detected with radioactive substances.
- Prime Minister instructed local governments concerned to restrict distribution and/or consumption of foods concerned in accordance with Special Law of Nuclear Emergency Preparedness.
  - Fukushima Pref. (Distribution restricted→spinach, kakina, raw milk, etc.)
  - Ibaraki, Tochigi, Gunma Prefs. (Distribution restricted→spinach, kakina)

### (2) Drinking Water

- MHLW notified water suppliers in prefectures concerned the followings regarding response to radioactive substances in tap water caused by the nuclear accident.
  - Refrain from drinking tap water exceeding index values (300Bq/kg for radioactive Iodine, 200Bq/kg for radioactive Cesium) .
  - In case radioactive Iodine exceeds 100Bq/kg, refrain from giving tap water to infants, including preparing infant formula.
  - There is no problem in using tap water for other domestic uses.
  - Lack of substitute drinking water.

## **7. Implementation Status of Radiation Monitoring**

## **7-1. Implementation Status of Radiation Monitoring(1/2)**

### **(1) On-site monitoring (1F) (conducted by TEPCO)**

#### **① Measurement of air dose rates**

- On site, air dose rates were measured at 1 point using monitoring car and at 3 points using portable dosimeter.

#### **② Analysis of soil samples**

- Soils were sampled at 5 on-site points and analyzed.

#### **③ Measurement of water in Turbine Bldg basement and Trench**

- Measured concentration of radioactive substances in Turbine Bldg basement and Trench.

#### **④ Sampling of seawater**

- Measured concentration of radioactivity around South Flood Gate.

## 7-1. Implementation Status of Radiation Monitoring(2/2)

### (2) Off-site Monitoring (conducted by MEXT and local nuclear emergency response HQ)

#### ① Measurement of air dose rate

Measurement by monitoring car

- MEXT measured air dose rate beyond 20km from 1F using monitoring cars in cooperation with Fukushima Pref., National Police Agency, Defense Ministry, Electric Utility and others concerned.
- local nuclear emergency response HQs measured air dose rate beyond 30km from 1F.

#### ② Measurement of cumulative dose

- MEXT measured cumulative dose rates by installing simplified dosimeters at 10 points.
- local nuclear emergency response HQs measured it by setting equipment 20~50km from 1F.

#### ③ Measurement of radioactive substance concentration in soil, etc.

- MEXT collected dust and soils beyond 20km from 1F and analyzed radioactive substance concentrations in the air and soils.
- local nuclear emergency response HQs measured concentrations in tap water, leaf vegetables, soil and dust in Fukushima Pref.

#### ④ Off-shore monitoring

- MEXT sampled seawater from surface water (1m from the sea surface) and sub-surface (10m above the sea bottom) around 30km off-shore Fukushima Pref. and measured radioactive substance concentrations and also measured air dose rates.

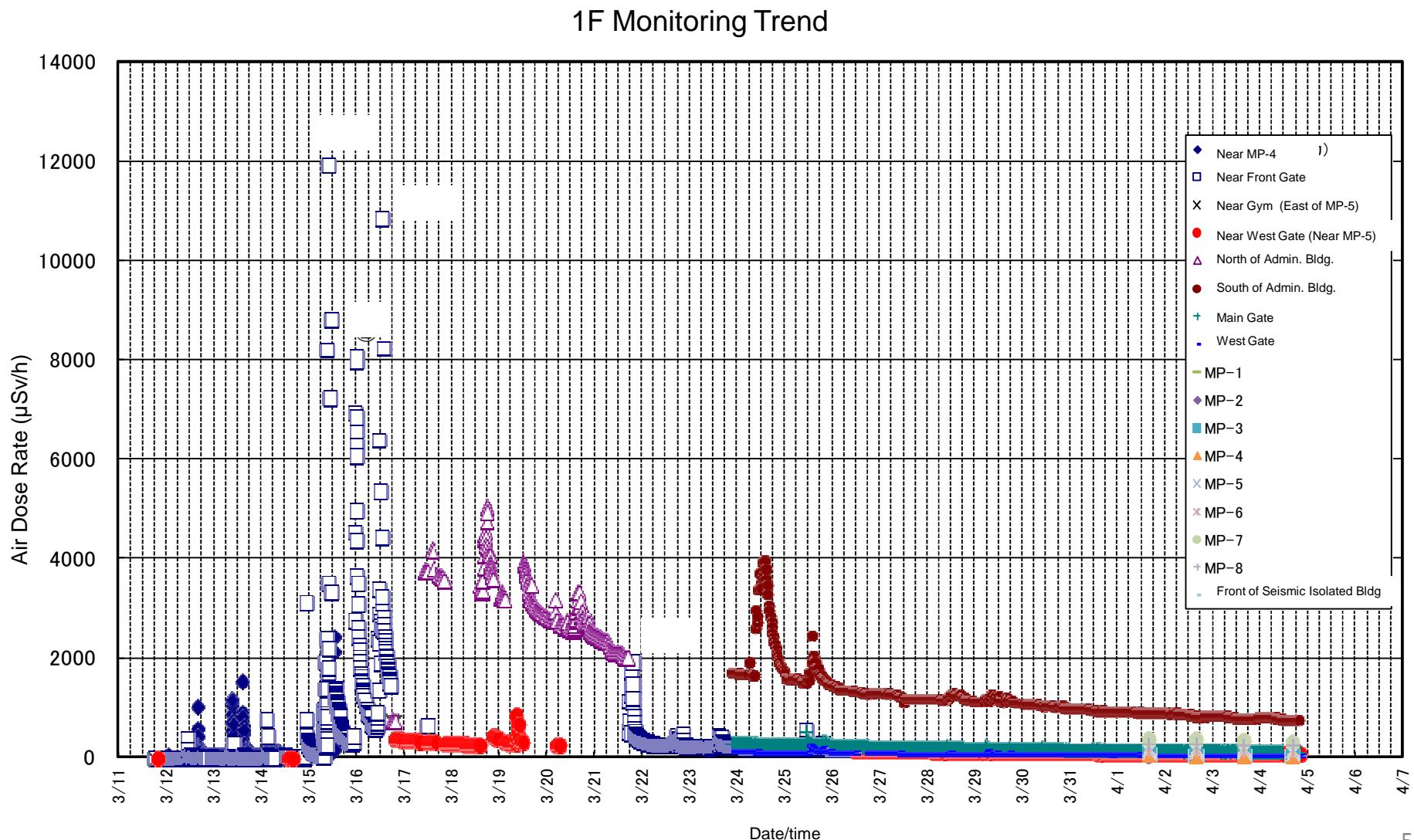
#### ⑤ Aerial monitoring

- MEXT measured radioactive substance concentrations and dose rates in the air using aircrafts.

## 7-2.Monitoring On-site(1F) (conducted by TEPCO)(1/7)

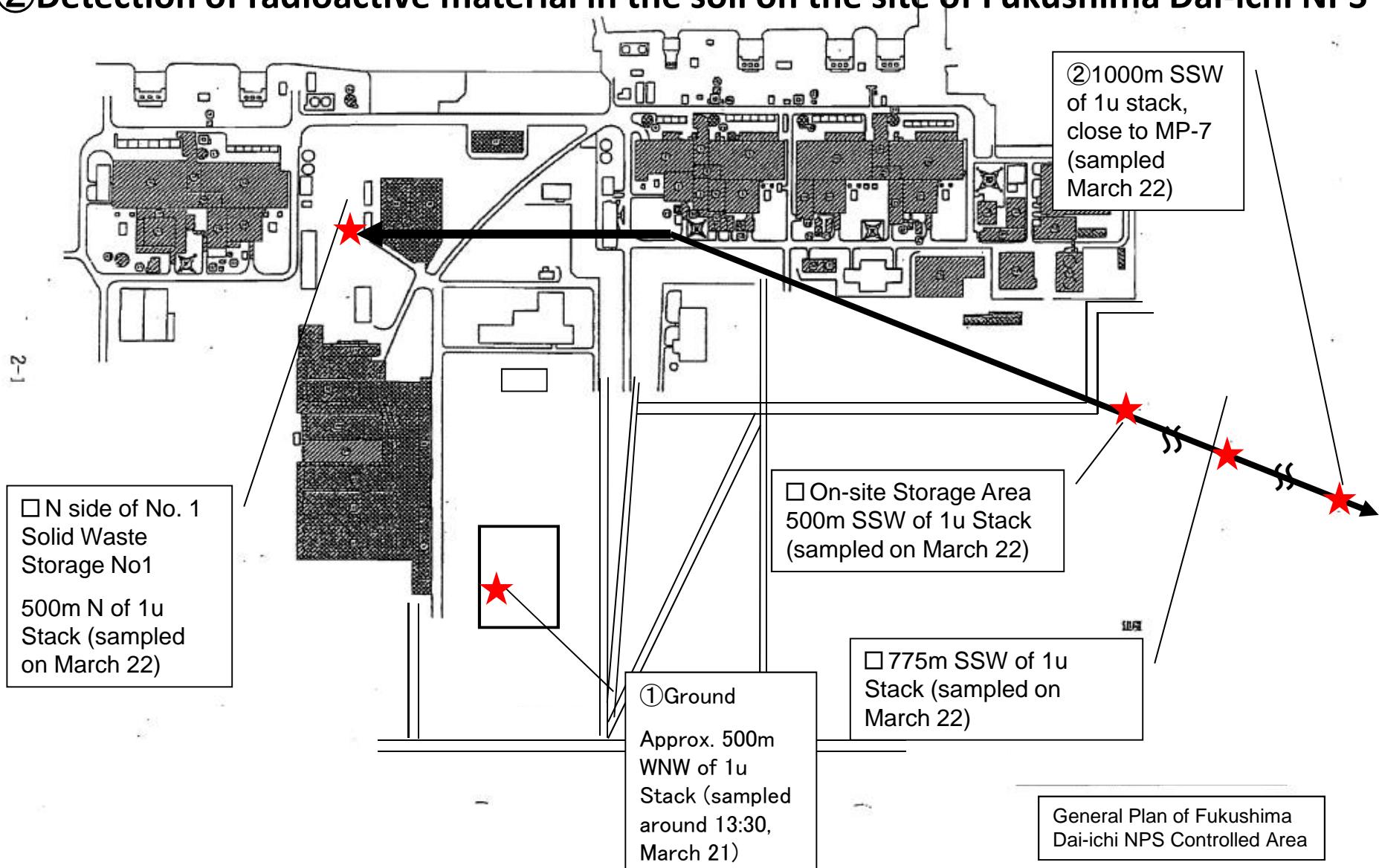
### ① Measurement of air dose rate

○ Registered 11930 $\mu$ Sv/h around Front Gate on March 15.



## 7-2.Monitoring On-site(1F) (conducted by TEPCO)(2/7)

### ②Detection of radioactive material in the soil on the site of Fukushima Dai-ichi NPS



## 7-2.Monitoring On-site(1F) (conducted by TEPCO)(3/7)

### ②Detection of radioactive materials in the soils on the site of Fukushima Dai-ichi

- Density of detected Pu-238, Pu-239 and Pu-240 are within the same level of the fallout observed in Japan after the atmospheric nuclear test in the past.
- Activity ratio of Pu-238 detected at the site field and solid waste storage against Pu-239 and Pu-240 are 2.0 and 0.94 respectively. Those Pus are considered to come from the recent incident.

(Unit: Bq/km<sup>2</sup>·dry soil)

Sampling Spot	Time of sampling	Pu-238	Pu-239, Pu-240
①Site field	13:30, March 21	$(5.4 \pm 0.62) \times 10^{-1}$	$(2.7 \pm 0.42) \times 10^{-1}$
②1km away from Unit ½ exhaust stack	7:00, March 22	N.D	$(2.6 \pm 0.58) \times 10^{-1}$
③0.75km away from Unit ½ exhaust stack	7:10, March 22	N.D	$1.2 \pm 0.12$
④0.5 km away from unit ½ exhaust stack	7:18 March 22	N.D	$1.2 \pm 0.11$
⑤Solid waste storage	7:45 March 11	$(1.8 \pm 0.33) \times 10^{-1}$	$(1.9 \pm 0.34) \times 10^{-1}$
Ordinary domestic soil		N.D $\sim 1.5 \times 10^{-1}$	N.D $\sim 4.5$

## 7-2.Monitoring On-site(1F) (conducted by TEPCO)(4/7)

### ③Water in Turbine Bldg Basement (Results of nuclide analysis in the stagnant water in turbine building basement of each Unit)

- There is pool of water with high radioactive substance concentration in turbine bldg basement of Units 1~4. Above 1,000mSv/h dose has been measured at water surface in Unit 2.
- Water with approx. 100,000 times normal radioactivity concentration in reactor water was confirmed in turbine bldg basement of Unit 2.

Nuclide (half-life time)	Concentration of Radioactivity (Bq/cm <sup>3</sup> )			
	Unit 1 (2nd time) Sampled on March 26	Unit 2 Sampled on March 26	Unit 3 (2nd time) Sampled on March 26	Unit 4 Sampled on March 24
	Water level 195mm	Water level 1,000mm	Water level 1,500mm	Water level 940mm
	Dose rate on the surface of the water 60 mSv/h	Dose rate on the surface of the water >1,000 mSv/h	Dose rate on the surface of the water 750 mSv/h	Dose rate on the surface of the water 0.50 mSv/h
Co-56 (about 77 days)	N.D	N.D	N.D	N.D
Co-58 (about 71 days)	N.D	N.D	N.D	$2.7 \times 10^{-1}$
Co-60 (about 5 years)	N.D	N.D	$2.7 \times 10^2$	N.D
Mo-99 (about 66 hours)	N.D	N.D	N.D	$1.0 \times 10^0$
Tc-99m (about 6 hours)	N.D	$8.7 \times 10^4$	$2.2 \times 10^3$	$6.5 \times 10^{-1}$
Ru-106 (about 370 days)	N.D	N.D	N.D	$3.3 \times 10^0$
Ag-108m (about 418 years)	N.D	N.D	N.D	N.D
Te-129 (about 70 minutes)	N.D	N.D	N.D	$2.6 \times 10^1$
Te-129m (about 34 days)	N.D	N.D	N.D	$1.3 \times 10^1$
Te-132 (about 3 days)	N.D	N.D	N.D	$1.4 \times 10^1$
I-131 (about 8 days)	$1.5 \times 10^5$	$1.3 \times 10^7$	$3.2 \times 10^5$	$3.6 \times 10^2$
I-132 (about 2 hours)	N.D	N.D	N.D	$1.3 \times 10^1$
I-134 (about 53 minutes)	N.D	N.D	N.D	N.D
Cs-134 (about 2 years)	$1.2 \times 10^5$	$2.3 \times 10^6$	$5.5 \times 10^4$	$3.1 \times 10^1$
Cs-136 (about 13 days)	$1.1 \times 10^4$	$2.5 \times 10^5$	$6.5 \times 10^3$	$3.7 \times 10^0$
Cs-137 (about 30 years)	$1.3 \times 10^5$	$2.3 \times 10^6$	$5.6 \times 10^4$	$3.2 \times 10^1$
Ba-140 (about 13 days)	N.D	$4.9 \times 10^5$	$1.9 \times 10^4$	N.D
La-140 (about 2 days)	N.D	$1.9 \times 10^5$	$3.1 \times 10^3$	$7.4 \times 10^{-1}$

## 7-2.Monitoring On-site(1F) (conducted by TEPCO)(5/7)

### ③Stagnant Water in Trench

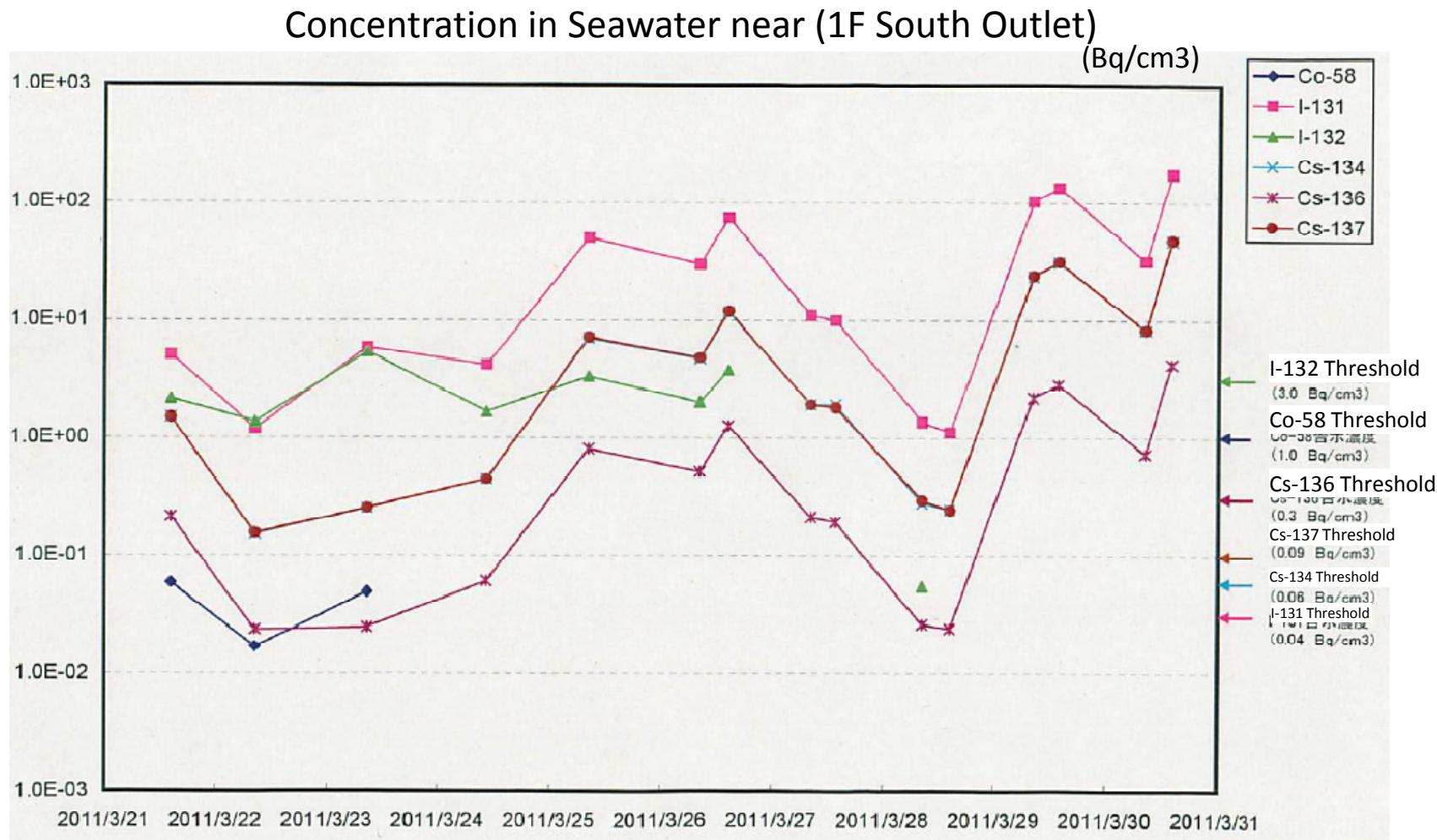
- High level of radiation dose was measured at the surface of water in the vertical pit of the tunnel called “trench” which extends from turbine bldg towards the sea.
- In particular, at Unit 2 ambient dosage around the vertical pit is 100~300mSv/h and dosage in surface water 1,000mSv/h, which are far greater than in Units 1 and 3.

	Unit 1	Unit 2	Unit 3
Location of trench	<input type="radio"/> Approx. 56m to sea <input type="radio"/> 162m from turbine bldg (length of trench)	<input type="radio"/> Approx. 55m to sea <input type="radio"/> 76m from turbine bldg (length of trench)	<input type="radio"/> Approx. 69m to sea <input type="radio"/> 74m from turbine bldg (length of trench)
Trench volume (incl. vertical pit)	3,100m <sup>3</sup>	6,000m <sup>3</sup>	4,200m <sup>3</sup>
Depth of vertical pit	16.9m	16.3m	21.7m
Depth of water in vertical pit	16.8m	15.3m	20.2m
Dosage at water surface	0.4~1.9mSv/h	Above 1000mSv/h	Impossible to measure due to debris
Ambient dosage in vertical pit	0.4~1.0mSv/h	100~300mSv/h	0.8mSv/h

## 7-2.Monitoring On-site(1F) (conducted by TEPCO)(6/7)

### ④ Radioactivity Concentration of Seawater Samples Near 1F South Outlet

- Concentration of radioactive iodine 131 recorded on March 31<sup>th</sup> was approx. 4385 times the limit set for water outside the environmental monitoring area.

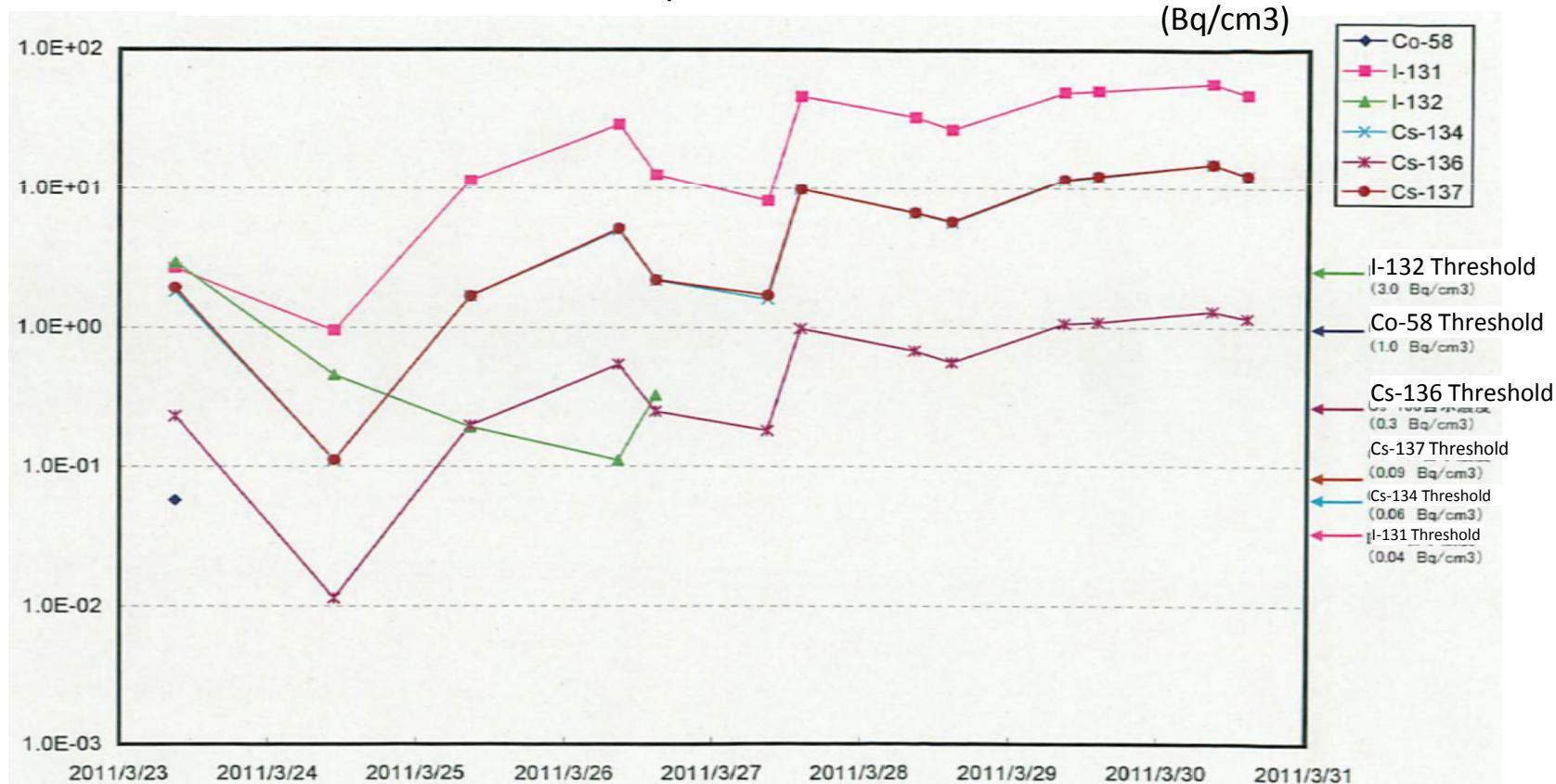


## 7-2.Monitoring On-site(1F) (conducted by TEPCO)(7/7)

### ⑤ Radioactivity Concentration of Seawater Samples Near Unit 5 and 6 of 1F in North Outlet

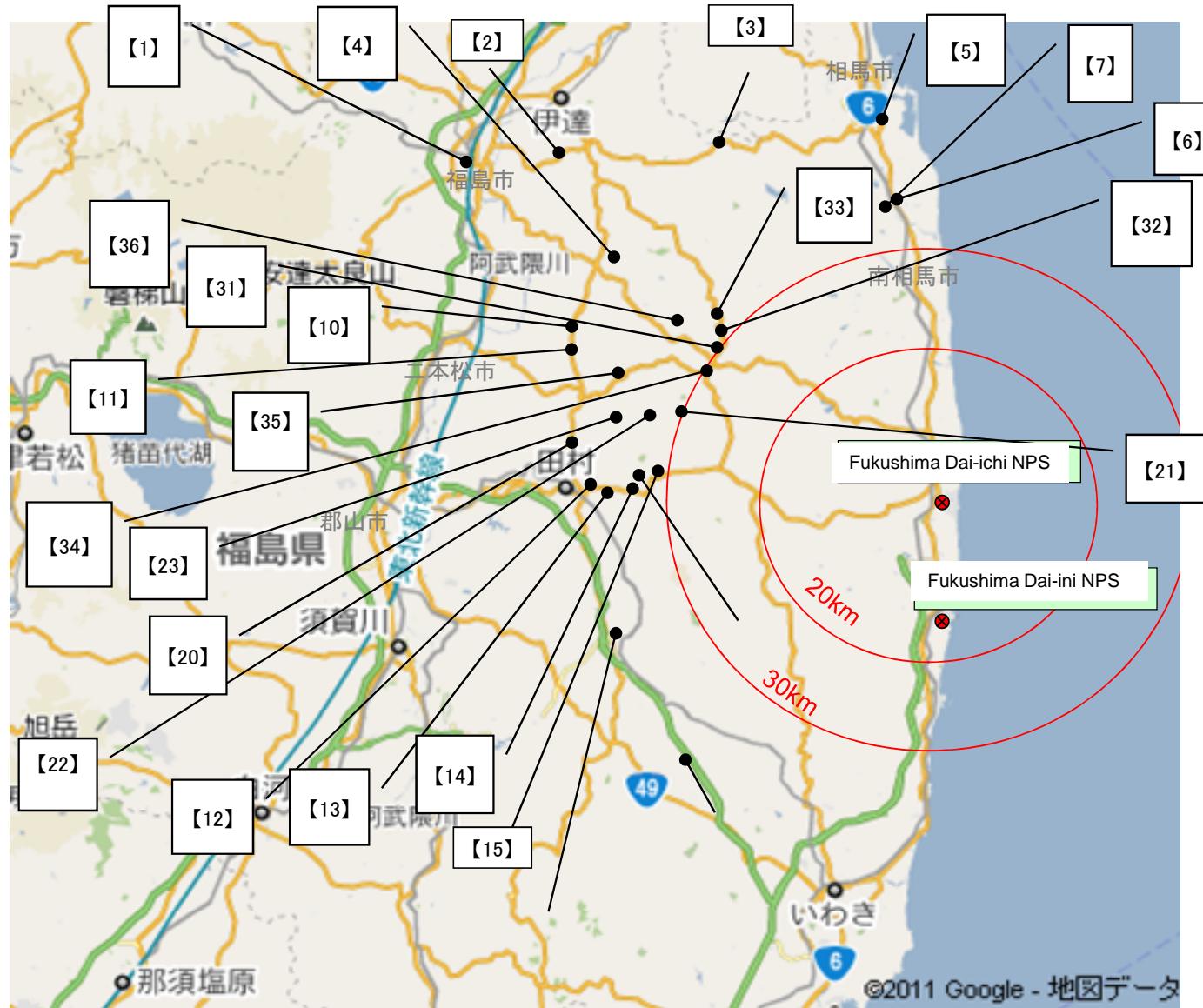
- Concentration of radioactive iodine131 recorded on March 31<sup>th</sup> was approx. 1425 times the limit set for water outside the environmental monitoring area.

1F 5-6 Northern Water Discharge Canal (Around 30 m north of The 5-6u canal) Radioactive concentration



## 7-3. Monitoring by MEXT and local nuclear emergency response HQ(1/6)

### ① Air Dose Rate Measuring Locations Using Monitoring Vehicles

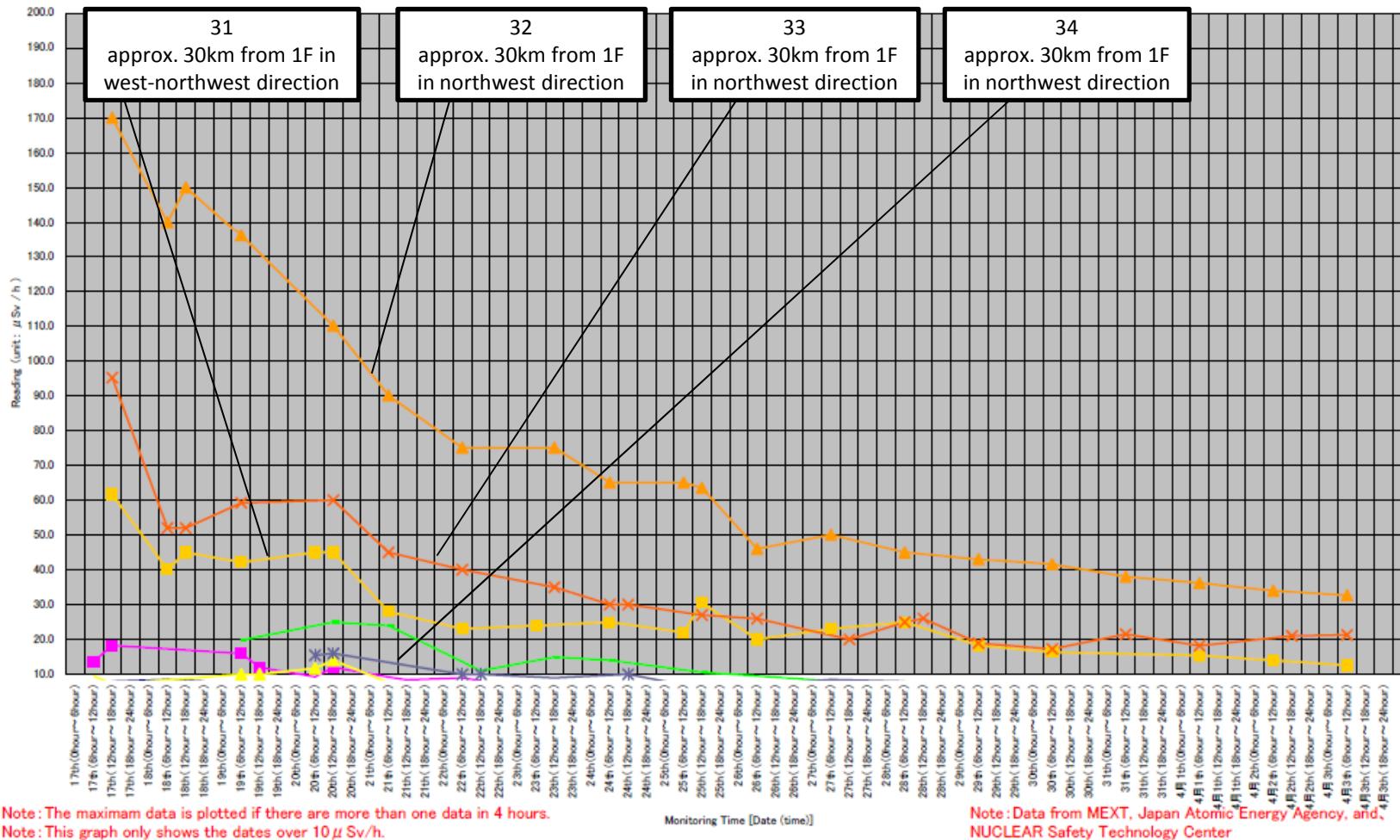


## 7-3. Monitoring by MEXT and local nuclear emergency response HQ(2/6)

### ① Air Dose Rate Measured Using Monitoring Vehicles

- Overall dose rate trending down since March 17<sup>th</sup>.
- E.g. The highest value recorded at Monitoring Point #32 has peaked out at approx. 170 $\mu$ Sv/h and has been declining since, rendering no immediate health hazard.

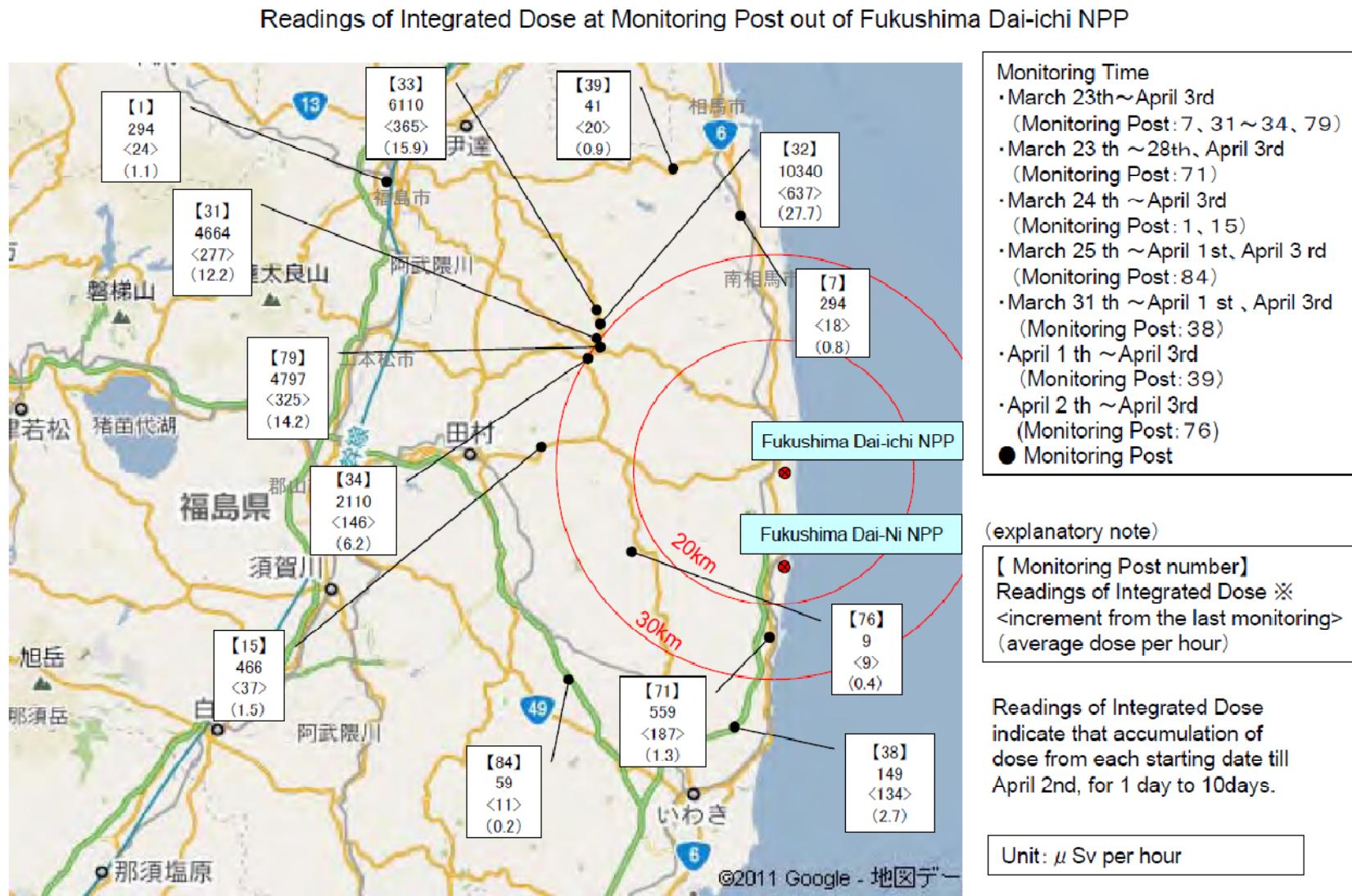
Readings at Monitoring Post out of 20 Km Zone of Fukushima Dai-ichi NPP



## 7-3. Monitoring by MEXT and local nuclear emergency response HQ(3/6)

### ② Cumulative Doses Measured

- Air dose rate cumulatively measured since April 3 topped 10,340 $\mu\text{Sv}$  at #32, approximately 30km North West from 1F.



## 7-3. Monitoring by MEXT and local nuclear emergency response HQ(4/6)

### ③Concentration of Radioactive Materials

#### ●Soil Samples

Sampling Point	Address of Sampling Point	Sample	Sort or Region	Sampling Time and Date	Radioactivity Concentration (Bq/kg)	
					<sup>131</sup> I	<sup>137</sup> Cs
[2-1] (About40kmNorthWest)	Itate Village	Land Soil	Soil	2011/3/19 11:40	300,000	28,100
	Itate Village	Land Soil	Soil	2011/3/20 12:40	1,110,000	163,000
	Itate Village	Land Soil	Soil	2011/3/21 12:32	207,000	39,900
	Itate Village	Land Soil	Soil	2011/3/22 12:00	256,000	51,400
	Itate Village	Land Soil	Soil	2011/3/23 12:25	135,000	32,200
	Itate Village	Land Soil	Soil	2011/3/24 13:05	45,500	1,870
	Itate Village	Land Soil	Soil	2011/3/25 13:05	265,000	21,900
	Itate Village	Land Soil	Soil	2011/3/26 12:00	564,000	227,000
	Itate Village	Land Soil	Soil	2011/3/26 15:20	82,000	28,000
	Itate Village	Land Soil	Soil	2011/3/27 11:40	169,000	29,100
	Itate Village	Land Soil	Soil	2011/3/27 12:00	68,800	20,800
	Itate Village	Land Soil	Soil	2011/3/28 11:50	14,000	2,040
	Itate Village	Land Soil	Soil	2011/3/28 12:10	23,100	360
	Itate Village	Land Soil	Soil	2011/3/29 11:50	53,700	5,650
	Itate Village	Land Soil	Soil	2011/3/29 12:10	58,400	25,100
	Itate Village	Land Soil	Soil	2011/3/30 12:25	88,000	32,300
	Itate Village	Land Soil	Soil	2011/3/30 12:45	11,900	408
	Itate Village	Land Soil	Soil	2011/3/31 11:00	149,000	21,600
	Itate Village	Land Soil	Soil	2011/3/31 11:45	60,800	26,500
	Itate Village	Land Soil	Soil	2011/4/1 11:30	146,000	43,700
	Itate Village	Land Soil	Soil	2011/4/1 12:05	21,400	1,410
	Itate Village	Land Soil	Soil	2011/4/2 11:24	55,500	8,140
	Itate Village	Land Soil	Soil	2011/4/2 11:48	61,900	30,800

## 7-3. Monitoring by MEXT and local nuclear emergency response HQ(4/6)

### ③Concentration of Radioactive Materials

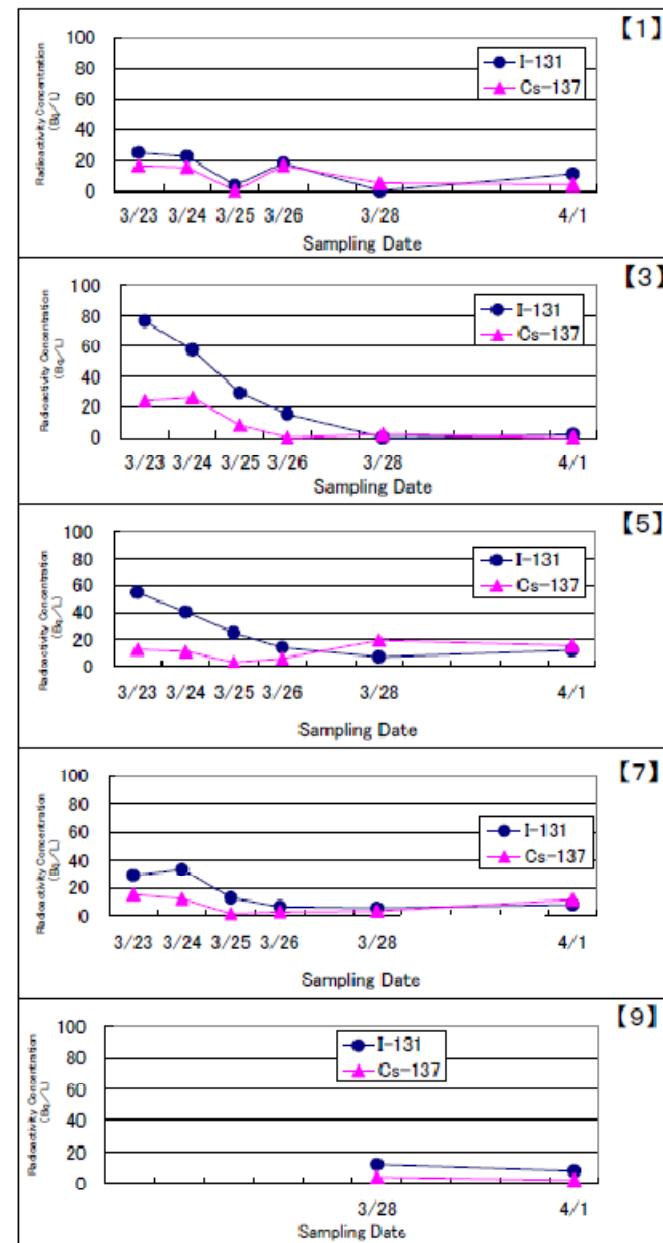
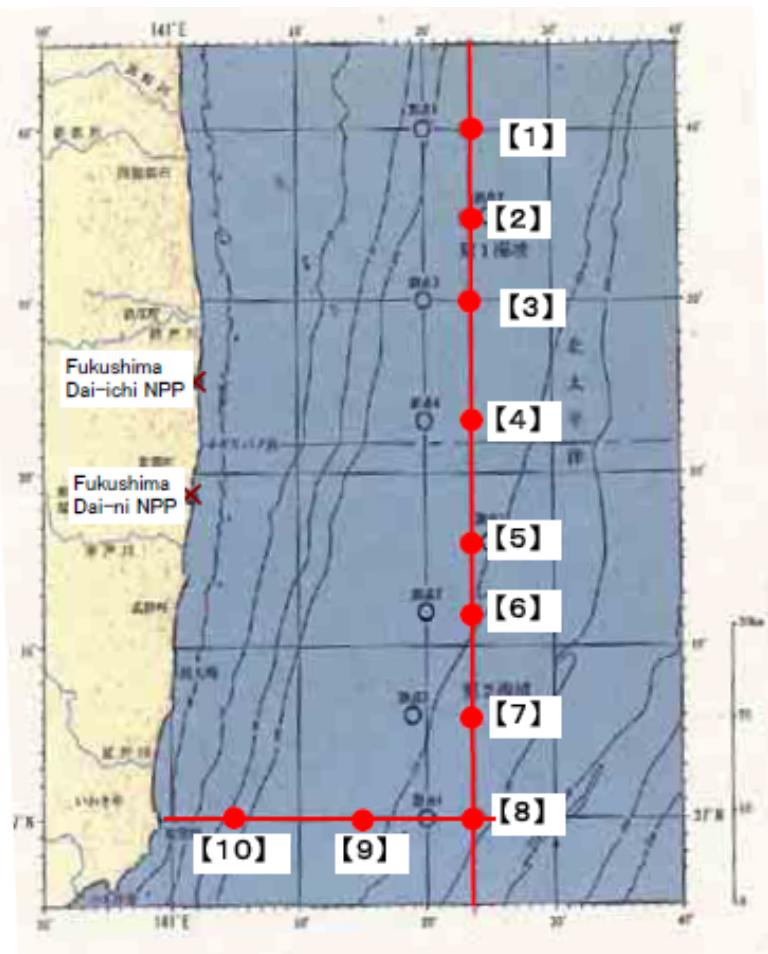
- Dust Samples

Sampling Point	Sampling Time and Date	Radioactivity Concentration (Bq/m <sup>3</sup> )		Reading: ( $\mu$ Sv/h)
		<sup>131</sup> I	<sup>137</sup> Cs	
【2-1】(About40 kmNorthWest)	3/21 13:00~13:20	12.80	2.37	4.1
	3/22 12:26~12:46	5.87	ND	4.2
	3/23 12:50~13:10	2.99	ND	16.8
	3/24 13:30~13:50	5.80	1.51	10.0
	3/25 12:45~13:05	5.87	ND	12.3
	3/26 12:26~12:46	5.39	1.33	7.8
	3/27 12:06~12:26	2.22	ND	11.2
	3/28 12:05~12:25	1.66	ND	9.6
	3/29 12:07~12:27	2.42	6.79	9.2
	3/30 13:22~13:42	3.47	LTD	8.5
	3/31 11:50~12:10	1.74	LTD	8.0
	4/1 12:00~12:20	1.78	1.69	7.7
	4/2 11:46~12:06	0.84	ND	8.6

## 7-3. Monitoring by MEXT and local nuclear emergency response HQ(5/6)

### ④ Sea Water Monitoring Around Fukushima Dai-ichi NPS

- Concentration of radioactive materials at location #3 peaked at 76.8Bq/L, exceeding the limit for the environmental monitoring area.



Note: "Not Detectable" is illustrated as 0Bq/L.

## 7-3. Monitoring by MEXT and local nuclear emergency response HQ(6/6)

### ⑤Aerial Monitoring

- Flight Details : April 1<sup>st</sup>, from 11:02 to 13:45, cloudless skies with S winds  
Average altitude 1070 meters above sea, average speed 220km/h

Main Reading Point	City	Latitude longitude	Altitude above sea level [ above ground level] (m)	Monitoring Time	Readings( $\mu$ Sv/h)
【 1 】	Shirakawa (Fukushima Prefecture)	37° 03. 39 ' N 140° 17. 38 ' E	1193 [851]	11:45	0. 0409
【 2 】	Iwaki (Fukushima Prefecture)	36° 32. 19 ' N 140° 53. 19 ' E	1209 [1203]	11:57	0. 0261
【 3 】	Tamura (Fukushima Prefecture)	37° 27. 16 ' N 140° 34. 19 ' E	1267 [844]	12:13	0. 0281
【 4 】	Shinchi-cho (Fukushima Prefecture)	37° 46. 46 ' N 140° 52. 50 ' E	1182 [1117]	12:23	0. 0275
【 5 】	Fukushima (Fukushima Prefecture)	37° 47. 12 ' N 140° 29. 47 ' E	900 [842]	12:37	0. 0234
【 6 】	Koriyama (Fukushima Prefecture)	37° 26. 33 ' N 140° 22. 46 ' E	933 [691]	12:47	0. 0402
【 7 】	Shirakawa (Fukushima Prefecture )	37° 09. 40 ' N 140° 12. 59 ' E	898 [502]	12:56	0. 0402
【 8 】	Utunomiya (Tochigi Prefecture)	36° 35. 02 ' N 140° 00. 49 ' E	888 [737]	13:14	0. 0147

## **8. Provision of Relevant Information Overseas**

## 8. Provision of relevant information overseas(1/2)

### 1. Communication to IAEA and its Member States

#### (1) ENAC Website

NISA has constantly been providing facility-related and other relevant information on the Emergency Notification and Assistance Convention Website, designed for member states to exchange information on nuclear accidents.

#### (2) IEC (IAEA)

NISA has constantly been providing the Incident and Emergency Centre of IAEA with press releases and other relevant information, as well as responses to questions on such communication.

#### (3) Others

##### -March 21<sup>st</sup> Technical Briefing

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 NPS accident.

##### -IAEA Expert Missions

The Government of Japan has been receiving IAEA expert missions to Japan.

## 8. Provision of relevant information overseas(2/2)

### 2. To International Media in Japan

#### (1) Foreign Media Briefing

- NISA joins relevant government agencies in daily foreign media briefings at the PM's official residence on March 14, 17 and every day afterwards.
- NISA officials give account to damages suffered at Fukushima NPSs and respond to questions.
- English documents distributed include updates on earthquake-related damage, status of F1 NPSs and monitoring results in the vicinity.

#### (2) Briefings for Diplomatic Representatives in Tokyo

- NISA joined the Ministry of Foreign Affairs in briefing sessions for Diplomatic representatives in Tokyo.
- Distributed press releases (English), provided explanations and answered questions.

#### (3) 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>

## **9. Remarks**

## 9. Remarks

- Continue to make every possible efforts to bring the situation under control
- Will identify the cause of the accident completely and review safety assurance measures
- Offer the information as much as possible and share the experience and knowledge of the accident with the international community