Additional Report of the Japanese Government to the IAEA

– The Accident at TEPCO's Fukushima NPSs – (Second report)

September 2011

Nuclear Emergency Response Headquarters

Introduction

Since June, each unit of Fukushima Dai-ichi NPS has been making a stable progress; the amount of released radioactive materials and the radiation exposure of workers have been significantly reduced, and the restoration from the accident has been steadily proceeding with Step 2, which sets as its target “the release of radioactive materials is under control and the radiation dose is being significantly held down”.

Meanwhile, off-site actions such as decontamination of the surrounding areas are being taken, and at the same time, an on-site plan after the settlement of the accident is also being developed.

Further, as a means to respond to the lessons, establishment of a renewed safety regulatory and administrative system has been clearly announced.

Developments of these situations are described as follows.

Major Actions taken since June

(1) Each unit of Fukushima Dai-ichi NPS has been making a stable progress, and the amount of released radioactive materials has been significantly reduced.

(2) Radiation exposure has also been significantly reduced.

(3) Efforts to settle the accident have been made to reach Step 2.

(4) Establishment of a renewed safety regulatory and administrative systems has been clearly announced.

(5) Comprehensive safety assessments on the safety of nuclear power stations (stress tests) will be conducted.

(6) Off-site actions such as decontamination are being actively taken. (Chapter 2)

(7) An on-site plan after the settlement of the accident is now being developed. (Chapter 3)

(8) More detailed comprehension and organization of the facts that have been found so far are being made.

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5. Efforts on the comprehensive safety assessments (stress tests) of NPS
6. Comprehension and organization of other facts

1. The stable condition of each unit of Fukushima Dai-ichi NPS and reduction of release of radioactive materials

The current situation of each unit of Fukushima Dai-ichi NPS

(1) Unit 1

- Cooling with water at a rate of approximately 3.6 m^3/h
  → Stably remaining below 100°C at present

(2) Unit 2

- Cooling with water at a rate of approximately 3.8 m3/h
  → Stably remaining below 130°C at present

(3) Unit 3

- Cooling with water at a rate of approximately 7.0 m3/h
  → Stably remaining below 120°C at present

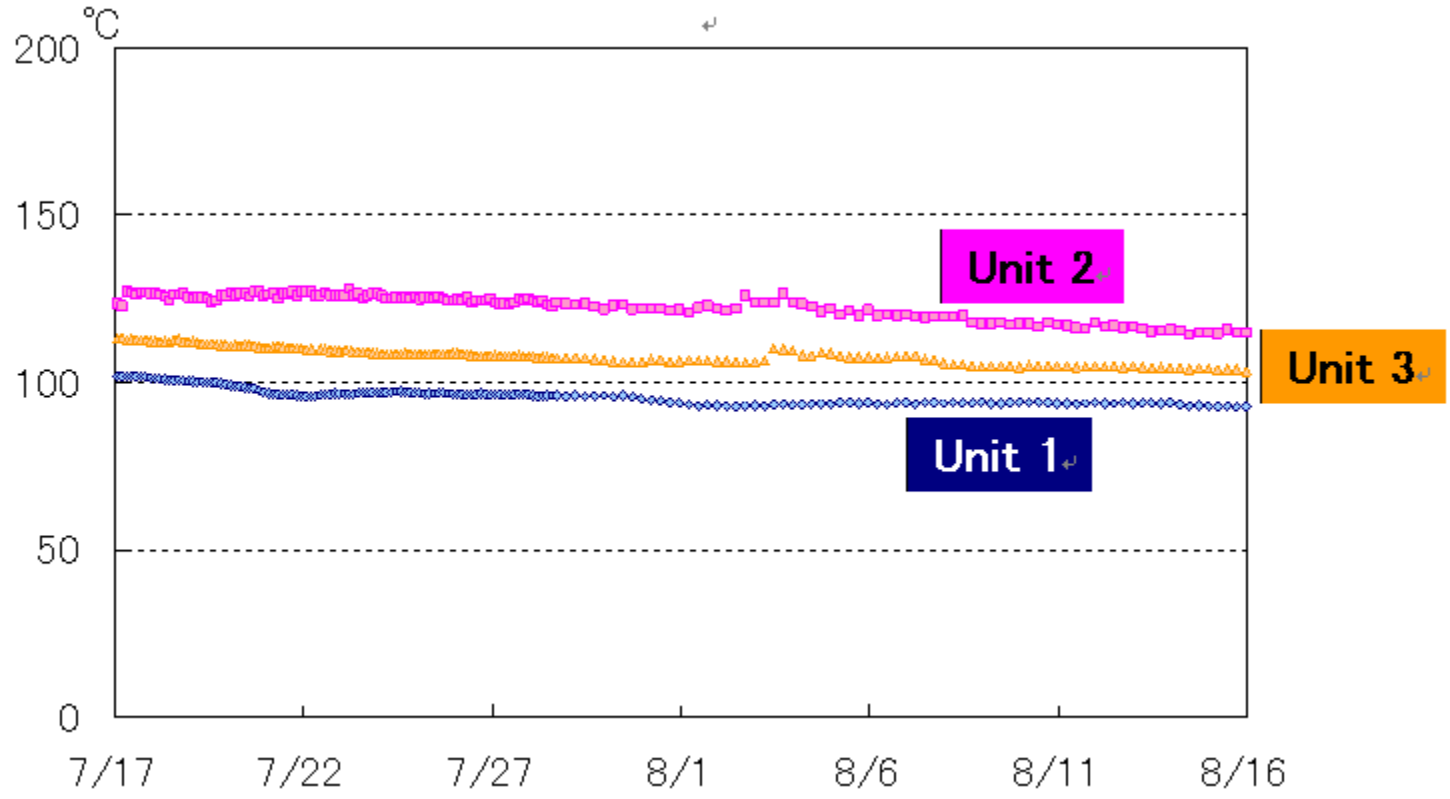
Status of Units 1, 2 and 3 of Fukushima Dai-ichi NPS

(As of August 31)

Unit	Unit 1	Unit 2	Unit 3
Status of water injection to the reactor	Fresh water feeding by feed water system Flow rate: 3.6m³/h	Fresh water feeding by feed water system Flow rate: 3.8m³/h	Fresh water feeding by feed water system Flow rate: 7.0m³/h
Reactor Water Level	Fuel range A: Downscale Fuel range B: -1,650mm	Fuel range A: -1,850mm* Fuel range B: -2,200mm*	Fuel range A: -1,350mm* Fuel range B: -1,850mm*
Reactor Pressure	0.017 MPa g(A) - MPa g(B)	0.014 MPa g(A) - MPa g(B)	-0.187 MPa g(A) -0.100 MPa g(B)
Temperature around the reactor vessel	Temperature in feed-water nozzle: 92.2 ºC Temperature at reactor vessel bottom: 87.4 ºC	Temperature in feed-water nozzle: 106.9 ºC Temperature at reactor vessel bottom: 113.5 ºC	Temperature in feed-water nozzle: 118.6 ºC Temperature at reactor vessel bottom: 109.2 ºC
Pressure in D/W, S/C	D/W: 0.1259 MPa abs S/C: 0.105 MPa abs	D/W: 0.115 MPa abs S/C: Downscale	D/W: 0.1015 MPa abs S/C: 0.1810 MPa abs
Status	Each plant receives electricity from external power supplies. The process is carried on ensuring reliability of cooling function by installing temporary emergency diesel generators and the seawater pump etc.		

* These data may be modified when TEPCO makes evaluates them.

Units 1, 2 and 3
(Current Temperature Condition of the RPV Bottom)



Reduction of Release of Radioactive Materials

(1) The amount of released radioactive materials has been significantly reduced.

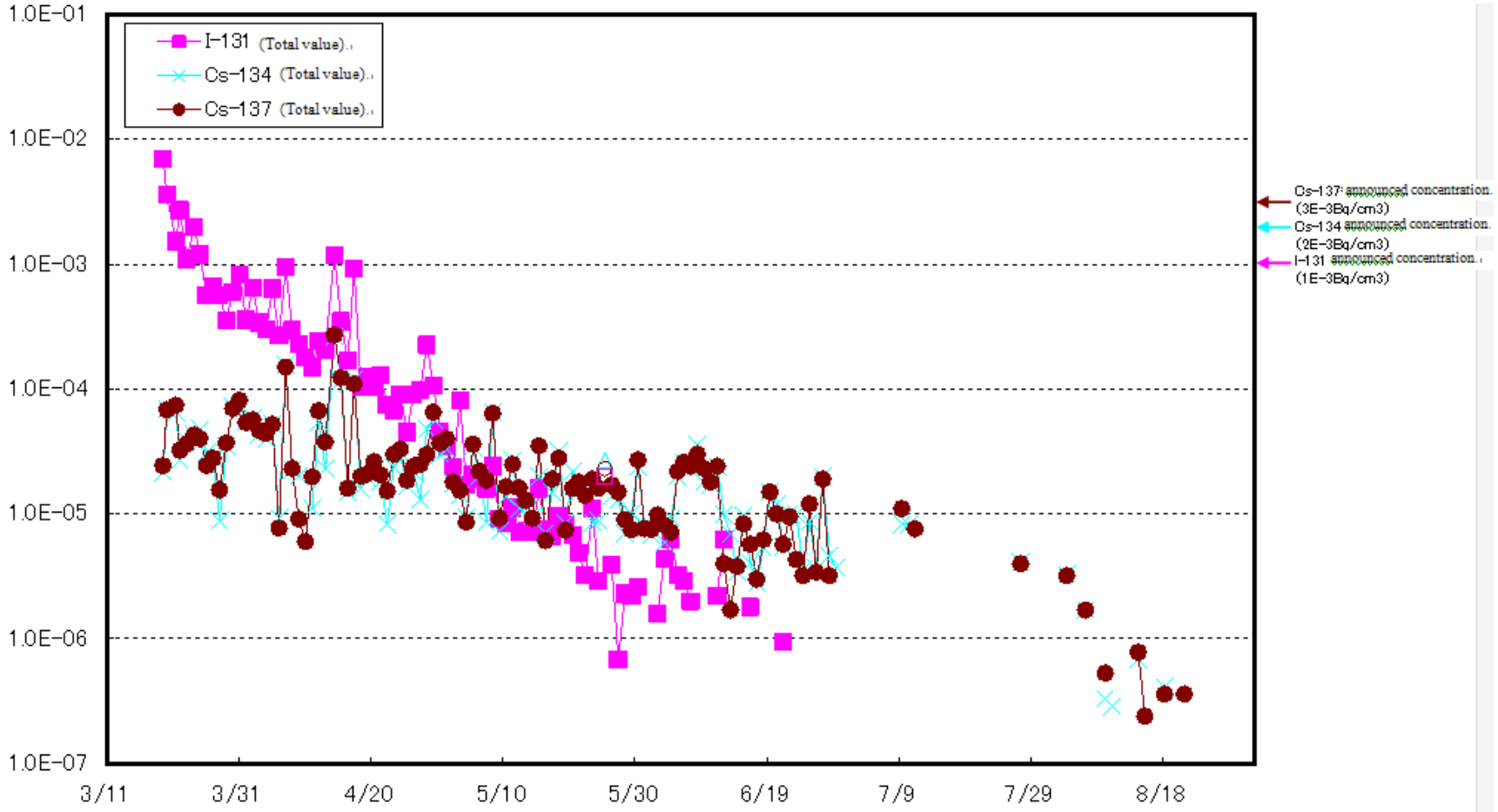
- Initially high levels of released materials (10^{15}–10^{16} Bq/h)
  → Currently low level (10^{8} Bq/h)

(2) The preventive measure for discharging into the sea has been strengthened.

- Implementing measures such as pit closure and silt fence installation

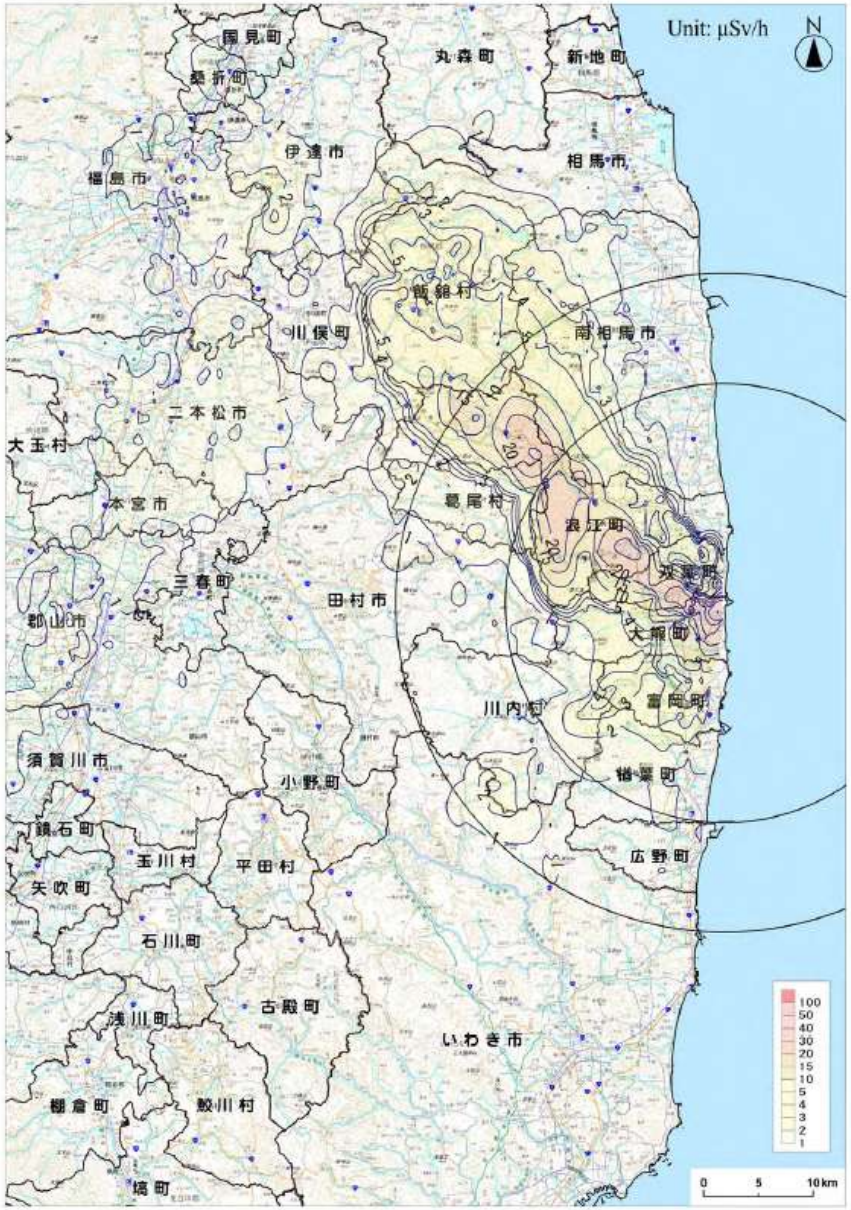
(3) The environmental monitoring system has been enhanced.

Fukushima Dai-ichi NPS: Trends in the Airborne Concentration of Radioactive Materials



Air Dose Rate Map

(As of August 11, 2011)



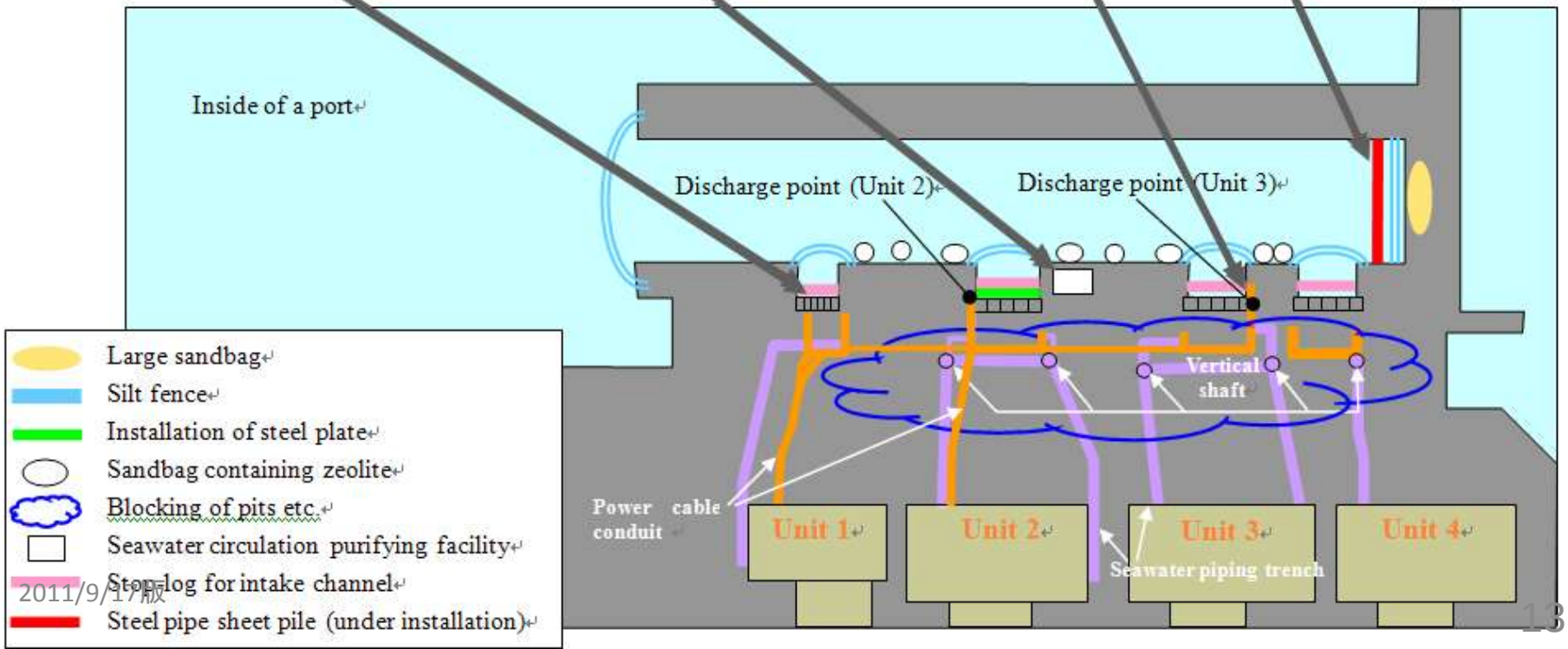
The state of enhancement measures to prevent contaminated water from flowing out and mixing with the sea

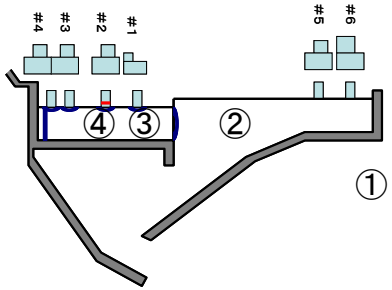
Photograph 1
Installation of Stop-Log

Photograph 2
Seawater Circulation Purifying Facility

Photograph 3
Blocking of Pits etc.

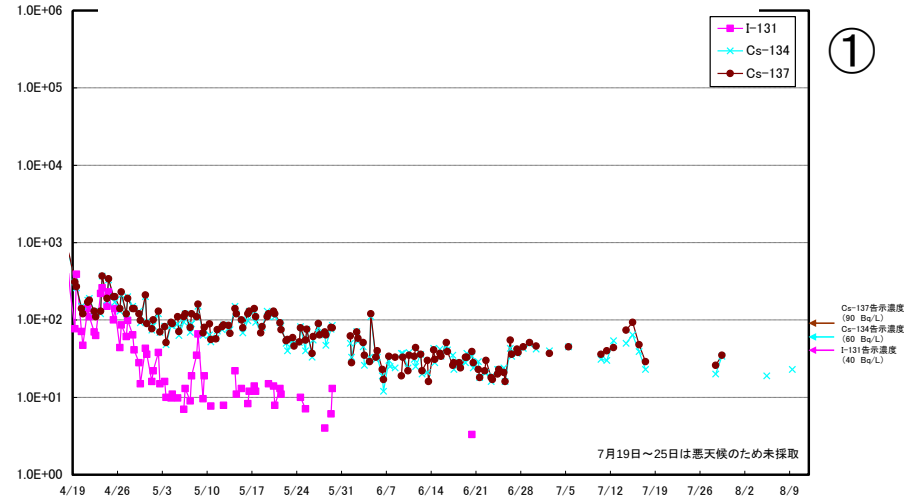
Photograph 4
Steel Pipe Sheet Pile (Example)



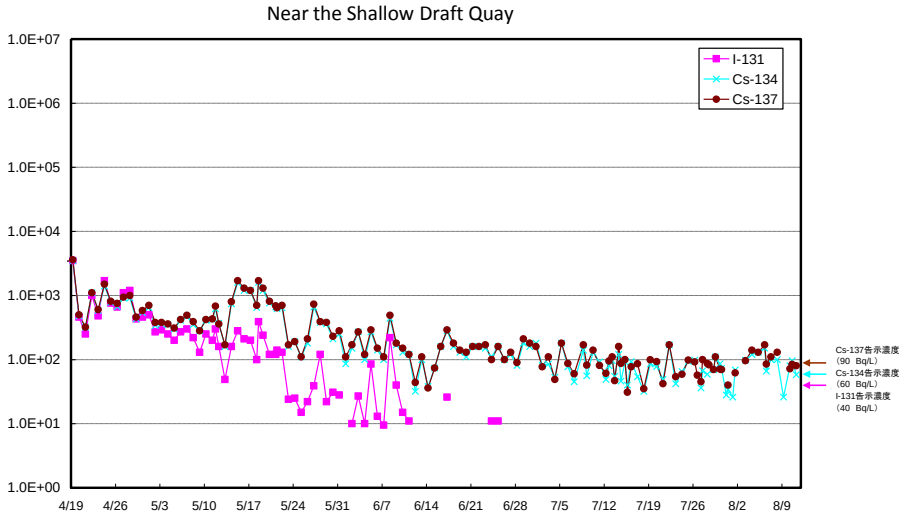


Monitoring around the Fukushima Dai-ichi NPS

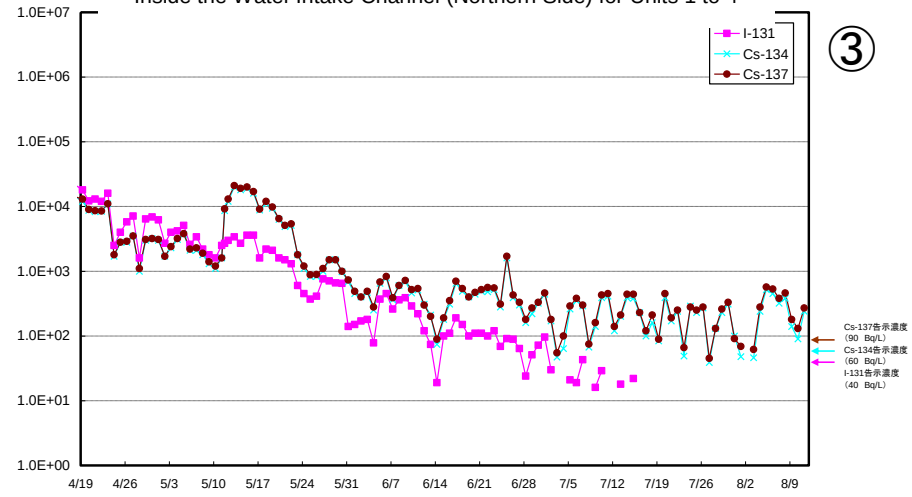
Northern Side of the Water Discharge Canal of 5 and 6



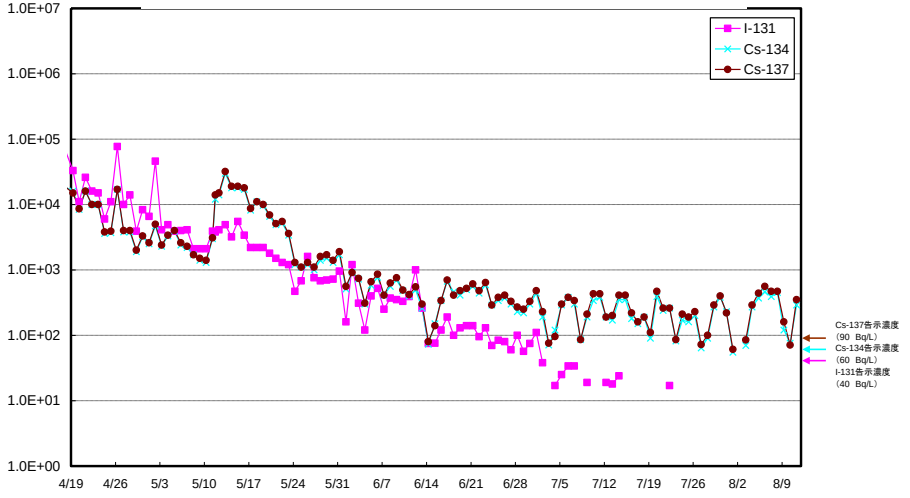
Near the Shallow Draft Quay



Inside the Water Intake Channel (Northern Side) for Units 1 to 4



At Unit 2 (Outside the Silt Fence)



Environmental Monitoring: Enhancing the System

(1) Coordination with concerned ministries and agencies, local government officials and the nuclear operator in the August 2 “Monitoring Coordination Meeting.” A Comprehensive Monitoring Plan was developed and air dose rates, etc. were systematically measured.

(2) The concentration of radioactive materials in the dust above the sea, seawater, and soil of the seabed off the coast of Miyagi, Fukushima, and Ibaraki Prefectures, etc. has been continuously measured.

2. Reduction of radioactive exposure

The Status of Radiation Exposure for Workers

(1) Radiation exposure doses for workers (external and internal doses) have been significantly reduced; the value 22.4mSv in average in March was reduced to 3.1mSv in average in May.

(2) In March, there were six workers whose exposure dose exceeded the 250 mSv emergency dose limit for workers (among them, the maximum exposure dose was approximately 670 mSv).

Survey on Health Care of Residents in Surrounding Areas

- The “Fukushima Prefecture Health Monitoring Survey,” targeting the approximately two million residents of Fukushima Prefecture, has been started.
  - A basic survey is being implemented based on records of behavior.
  - Then, a detailed survey will be implemented based on the basic survey (expected to target approximately 200,000 people).
  - Ultrasonography of the thyroid gland is being conducted for all Fukushima residents 18 years of age or younger.

3. Transition to Step 2 for the settlement of the accident

Efforts to Settle the Accident
(Transition to Phase 2)

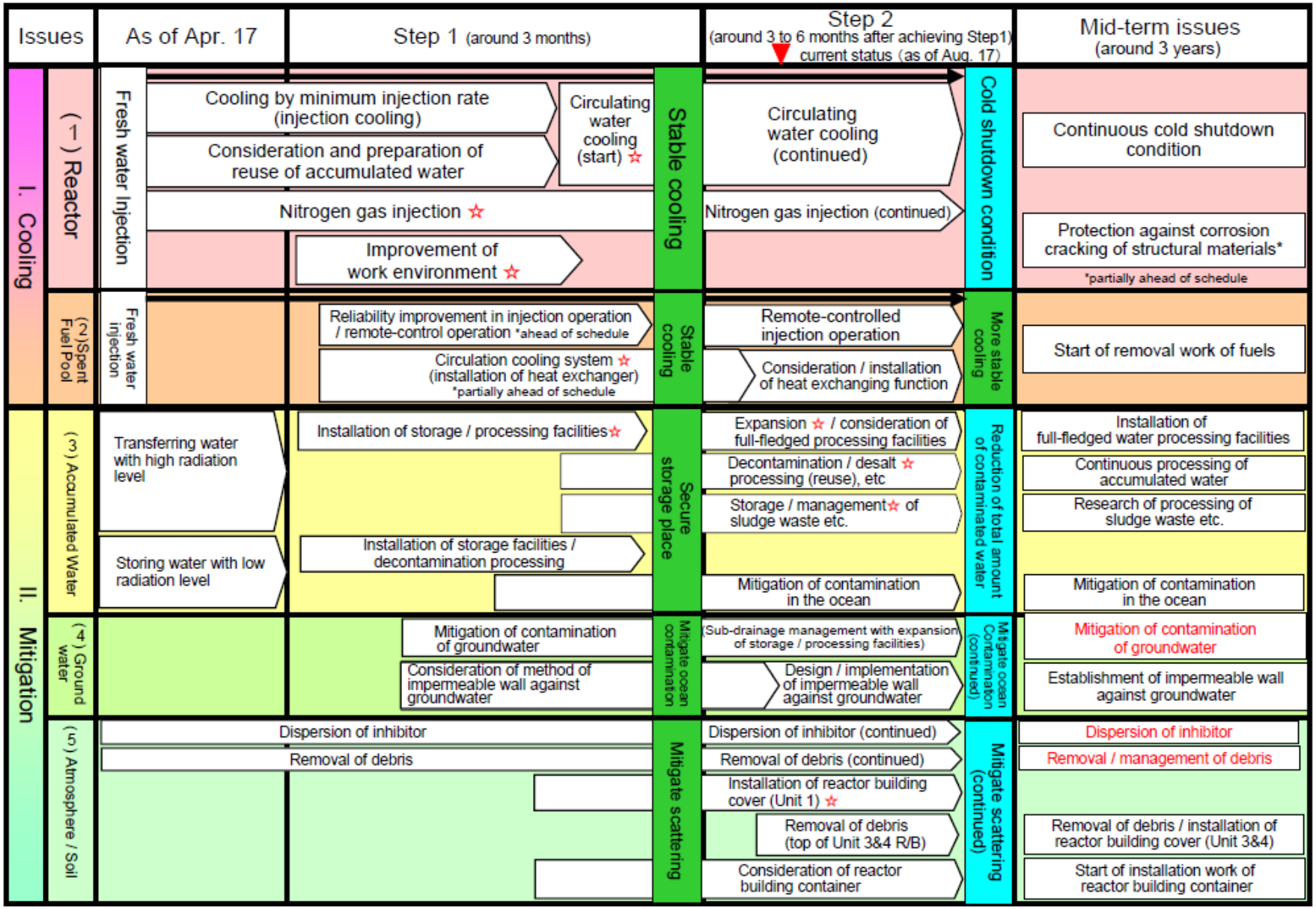
- Confirm the following to complete Phase 1 and transition to Phase 2 on July 19:
  - The trend of radiation dose is steadily reducing.
  - The cooling of the reactors and spent fuel pools is progressing.
  - Processing of accumulated water is progressing.

Current Status of "Roadmap towards Restoration from the Accident at Fukushima Dai-ichi NPS, TEPCO" (Revised edition)

Appendix 3

August 17, 2011
Nuclear Emergency Response Headquarters
Government-TEPCO Integrated Response Office

Red colored letter: newly added to the previous version, ☆: already reported to the government, Green colored shading: achieved object



Overview of Major Countermeasures in the Power Station as of August 17

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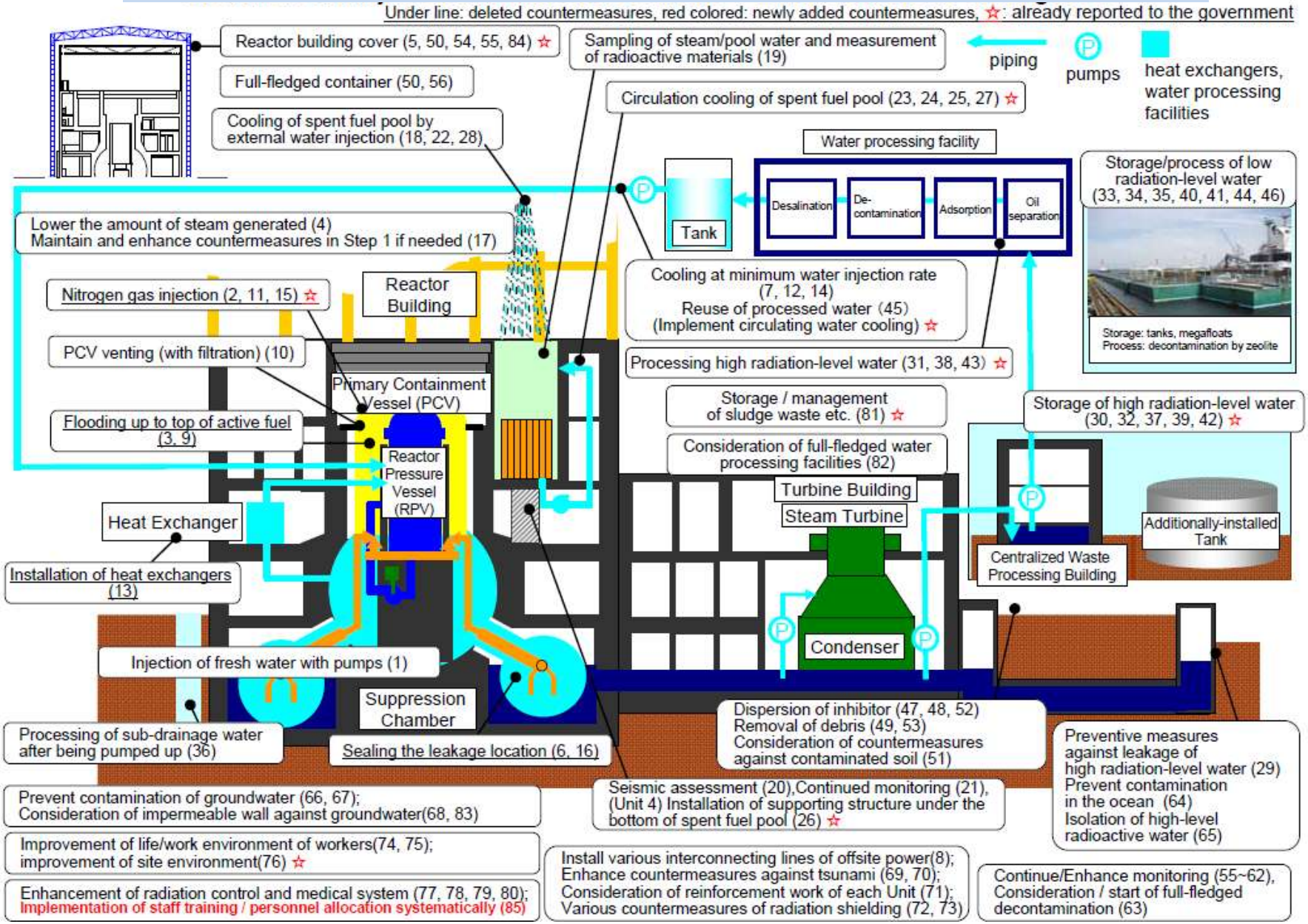
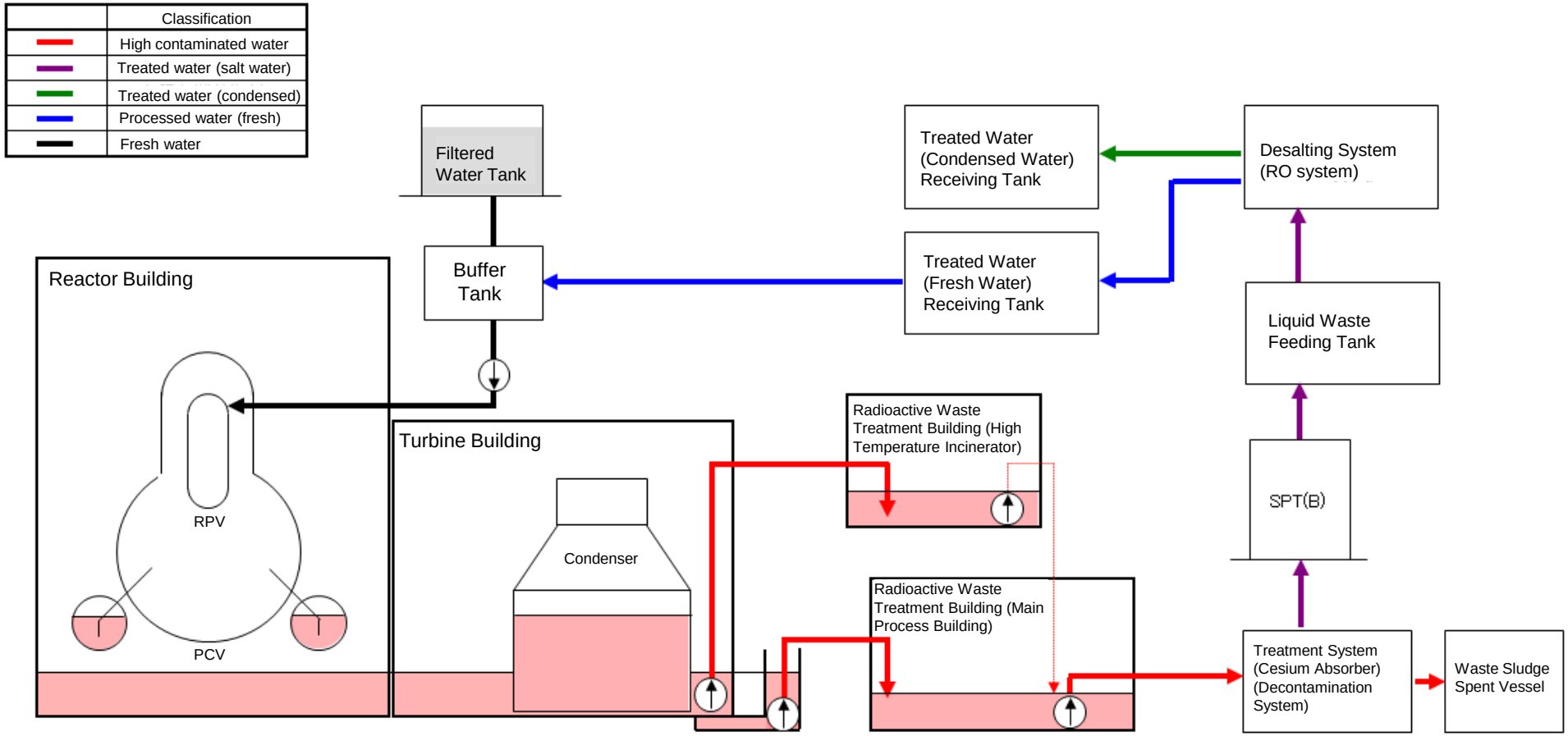


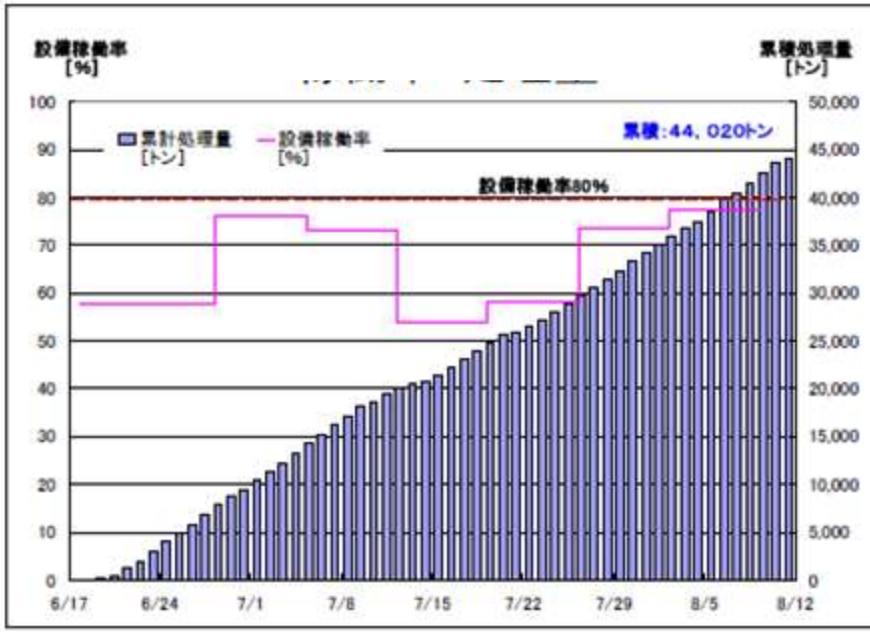
Circulating Injection Reactor Cooling System

Storage and treatment of high contaminated water

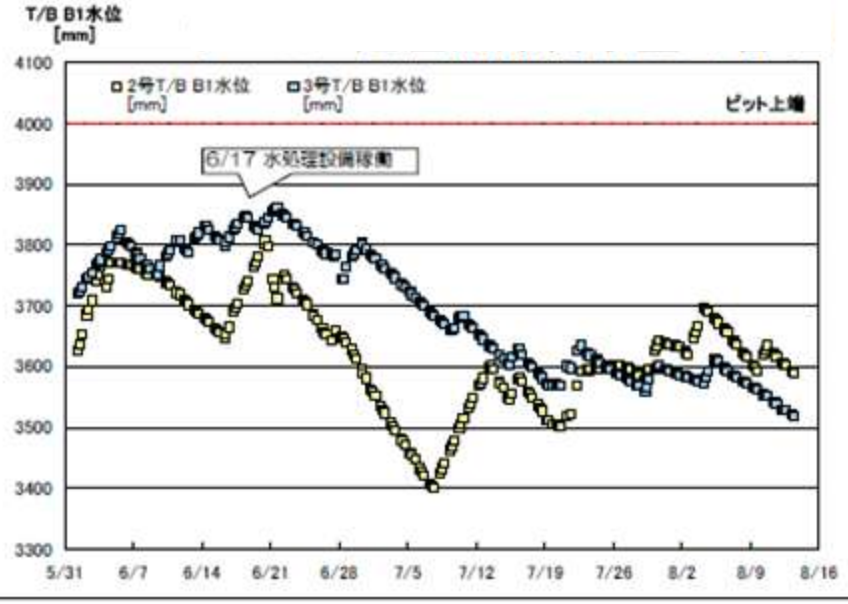


Track Records of Contaminated Water Processing

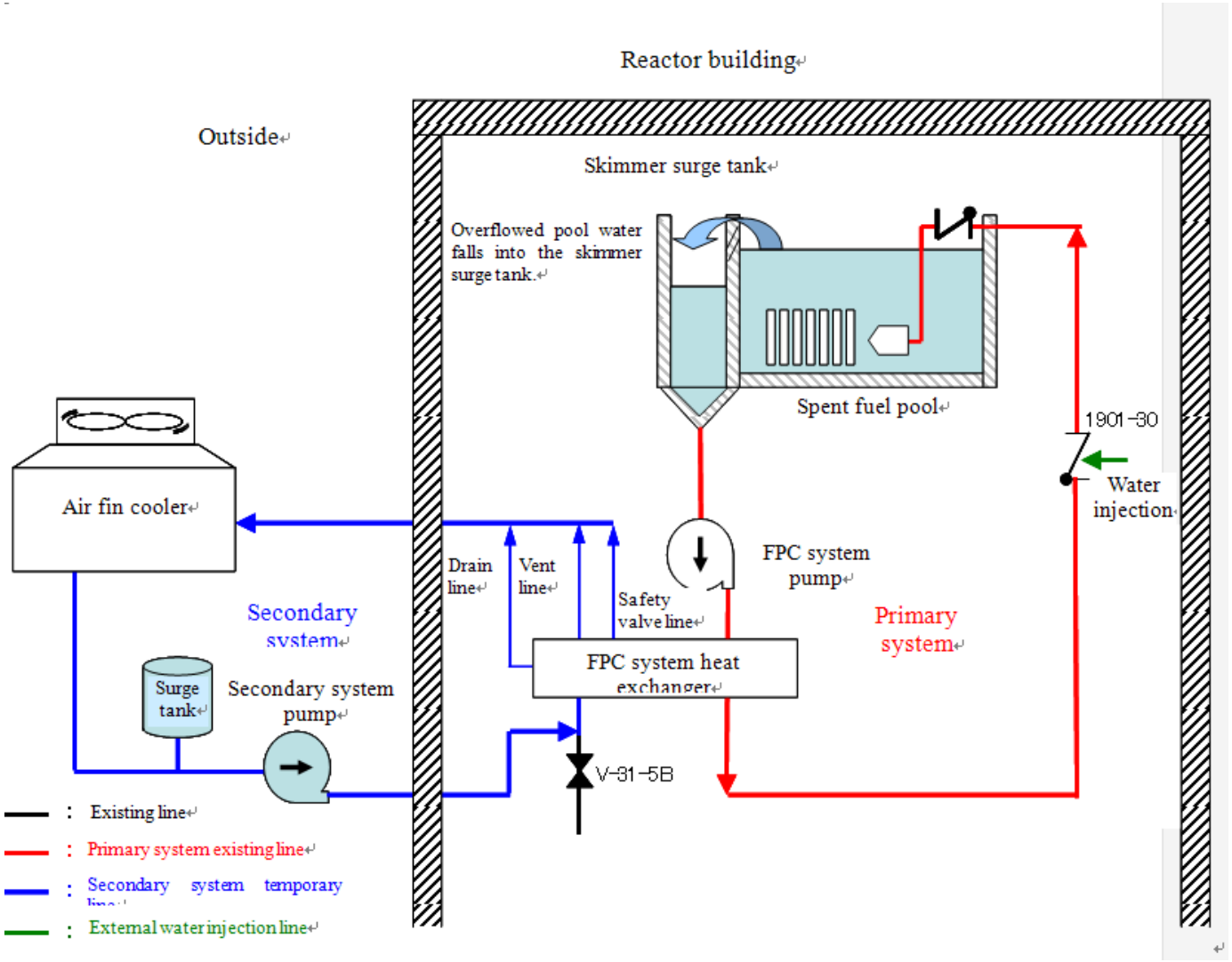
Operation factor rate & amount processed
Accumulated treatment amount (tons), facility operation factor (%)



Management of the water level of the accumulated water within the turbine building



Spent Fuel Pool: Alternative Cooling System (Unit 1)



Main Issues in Step 2

(1) Issue 1
Cooling the reactors: Evaluation of necessary flow rate of injecting water to achieve “cold shutdown condition”.

(2) Issue 2
Cooling the spent fuel pools: Achieving more stable cooling in all of the Units 1 through 4.

(3) Issue 3
Treating accumulated water: Decreasing the total amount of accumulated water and increasing the treatment volume to increase the water injection into the reactors.

(4) Issue 4
Shielding groundwater: Preventing the spread of contamination into the sea.

(5) Issue 5
Preventing the spread of radioactive materials in the atmosphere/soil: Mitigation of release of radioactive materials.

4. Establishment of a renewed safety regulatory and administrative systems

Enhancement of Safety Regulatory and Administrative Systems

- The establishment of a “Nuclear Safety and Security Agency” (provisional name) was approved by the Cabinet meeting on August 15.
  - Intent: to separate regulation from utilization
  - Positioning of the agency: as an external agency of the Ministry of Environment starting in April 2012
  - Necessary legislation: Established “Task Force for the Reform of Nuclear Safety Regulatory Bodies” (on August 26)

Concept of the Nuclear Safety and Security Agency
(tentative name)

(1) Centralize nuclear safety regulatory roles, which thus far have been divided among various ministries

(2) Develop a crisis management structure for the first response system, such as positioning experts to respond to emergencies

(3) Supervise the environmental monitoring function, including SPEEDI

(4) Ensure high-quality staffing, including establishment of an “International Nuclear Safety Training Institute” (provisional name)

5. Efforts on the comprehensive safety assessments (stress tests) of NPS

Comprehensive Safety Assessment (Stress Test)

Comprehensive safety assessments will be conducted based on new procedures and rules, with reference to the stress tests introduced in Europe, for enhancing the safety of nuclear power stations and ensuring safety and reliance for citizens and residents.

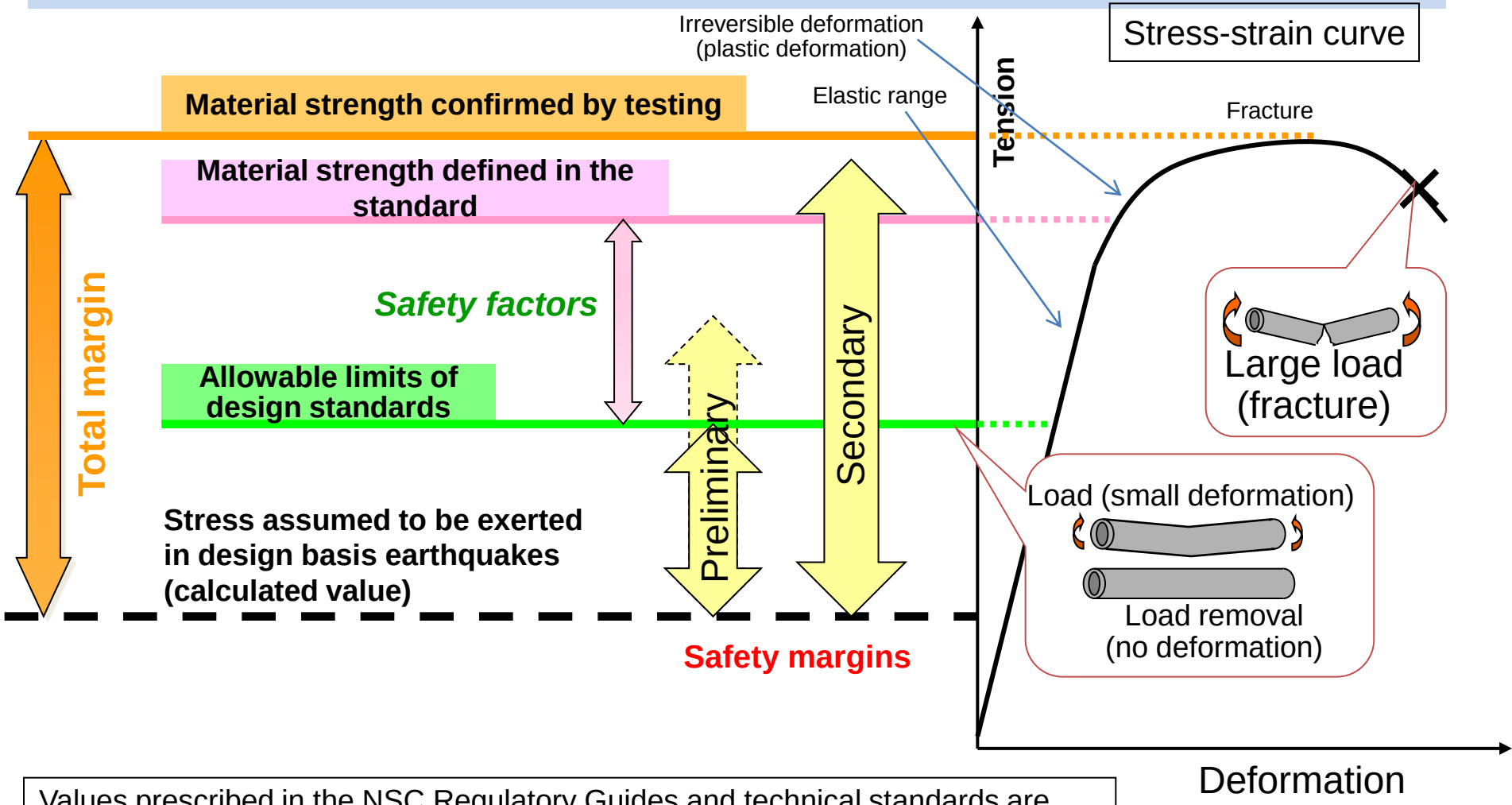
(1) Preliminary assessment:

The nuclear power stations, that are under shutdown due to regular inspections and are prepared for start-up, will be successively assessed on the safety margins of their facilities and equipment essential for safety against beyond-design-basis events.

(2) Secondary assessment:

Taking into account the implementation status of stress tests in Europe and what have been reviewed by the Investigation Committee on the Accidents at the Fukushima NPS, all nuclear power stations including the stations under operation and those evaluated in the preliminary assessment will be assessed on the comprehensive safety margins.

Safety margins for structural integrity of components and piping (Preliminary and Secondary assessments)



Values prescribed in the NSC Regulatory Guides and technical standards are used as allowable limits in preliminary assessment. Values exceeding allowable limits are applicable if it is technically verified in the preliminary assessment that the structure's integrity and functions are maintained. Factual assessment is conducted during secondary assessment to obtain values that cause the loss of structural integrity and functions.

6. Comprehension and organization of other facts

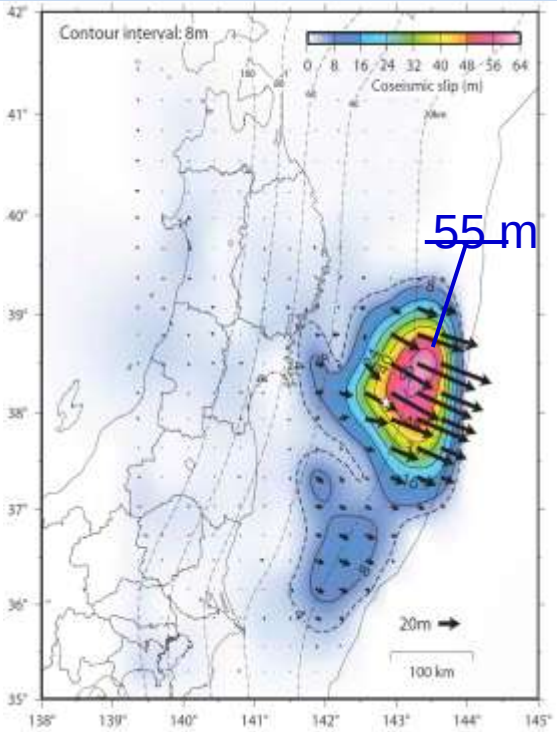
(1) The Tohoku District-Off the Pacific Ocean Earthquake and the resulting tsunamis

Tohoku District-Off the Pacific Ocean Earthquake and resulting tsunamis

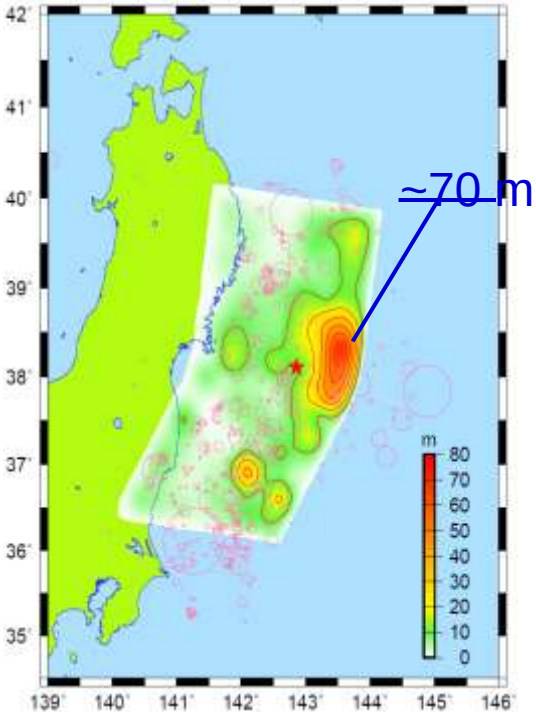
- A **large slip of 55m to not quite 70m** was estimated for the Tohoku earthquake in the shallow part of the plate boundary along the Japan Trench.
- There is a high probability that
  - ✓ the Tohoku earthquake was a giant earthquake of **M9** in viewpoint of **long period** ground motions;
  - ✓ however, it had the same characteristics as an **M8 earthquake** in viewpoint of **short period** ground motions.
- It is likely that
  - ✓ the large slip in the shallow area along the Japan Trench,
  - ✓ and the overlap effects of tsunami waves due to rupture delays associated with the interlocked rupturing of multiple source areas

  had large effects on tsunami water levels.

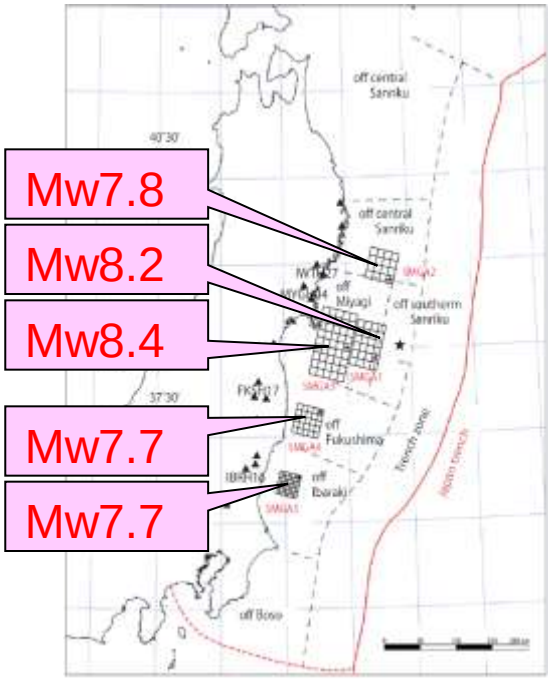
Source rupture process (Fault model)



Model proposed by GSI and JCG
- data: land area GPS observation and seafloor crustal deformation observation
- the maximum slip: 55 m



Model proposed by JNES
- moment magnitude: Mw 9
- location of large slip: along the Japan Trench

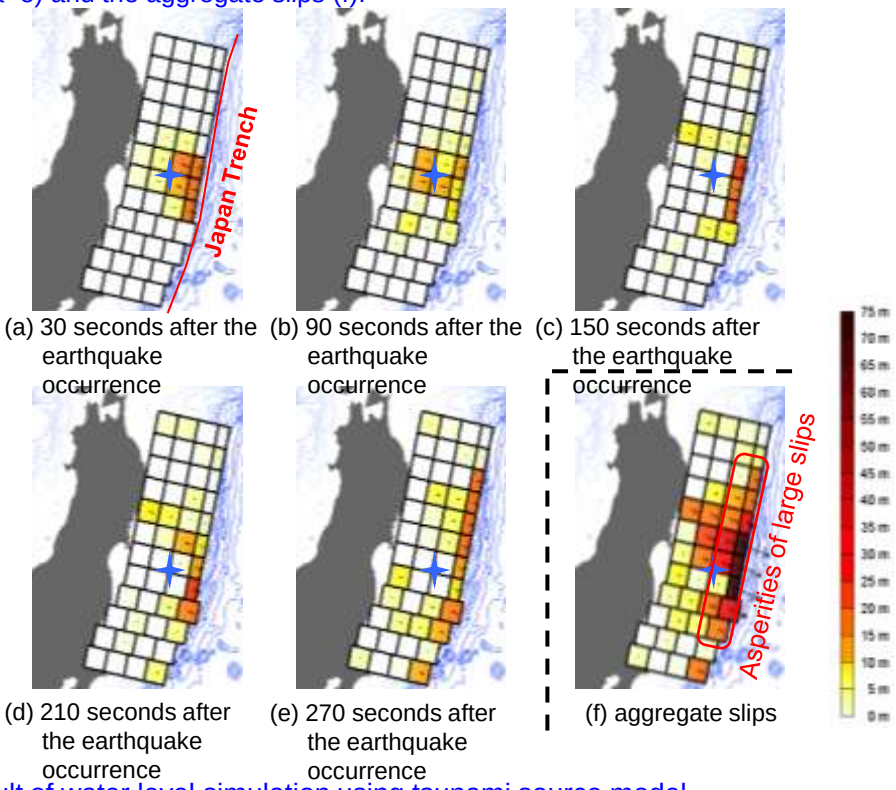


Model proposed by Irikura
- the number of asperities: 5
- concentrating in the deep part west to the hypocenter
- total energy: (as of moment magnitude) Mw 8.5

- There is a high probability that the Tohoku earthquake was a gigantic earthquake of M9 in terms of long-period ground motions,
- yet hat at the same time characteristics of an earthquake of M8 in terms of short-period ground motions.

Tsunami source rupture process (Tsunami source model)

■ Analysis results using tsunami source model: Trends in distribution of slips (a~e) and the aggregate slips (f).



(a) 30 seconds after the earthquake occurrence
(b) 90 seconds after the earthquake occurrence
(c) 150 seconds after the earthquake occurrence
(d) 210 seconds after the earthquake occurrence
(e) 270 seconds after the earthquake occurrence
(f) aggregate slips

Result of water level simulation using tsunami source model:

- Offshore areas: The simulated tsunami waveforms being consistent with the shape of the short-period ones of the observed first wave
- Nuclear sites : The simulated tsunami waveforms being consistent with observed ones

⇒Amount of large slips and asperities:
Locating in the shallow areas (400 km) along the Japan Trench, and resulting in the maximum slip of above 70 m

⇒Delay in rupture start time of multiple seismic source areas:
It is likely that overlap effect of tsunami waves due to the rupture delay had a great impact on tsunami water levels.

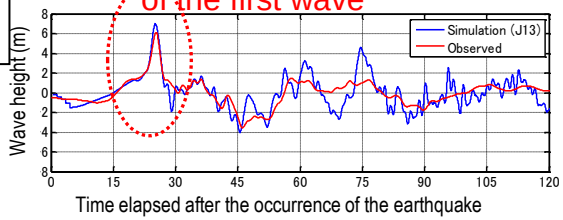
■ **Comparison of simulated tsunami waveform (blue) and observed one (red)**

Offshore areas

Off the southern coast of Iwate prefecture

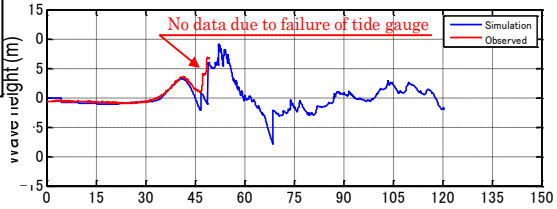
G802

The short-period waveforms of the first wave

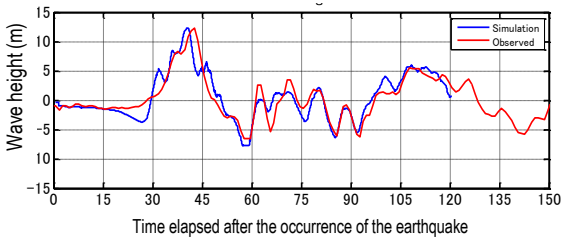


Nuclear sites

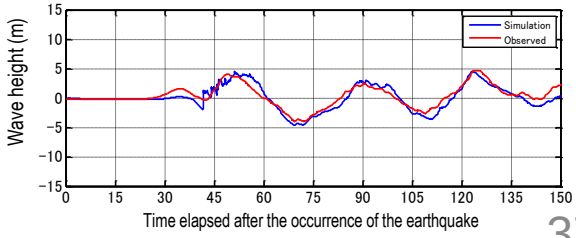
Fukushima Dai-ichi NPS



Onagawa NPS

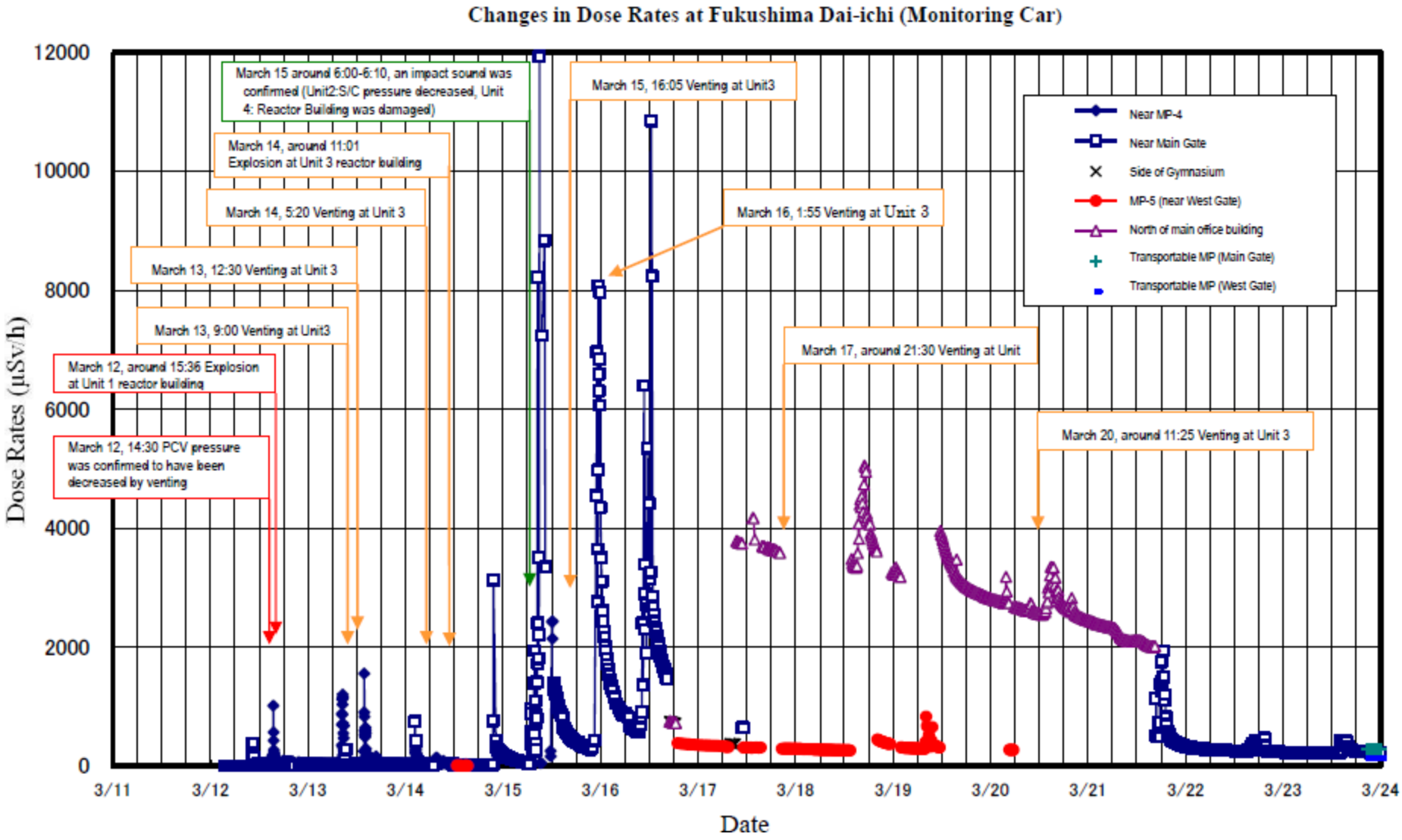


Tokai Dai-ni NPS

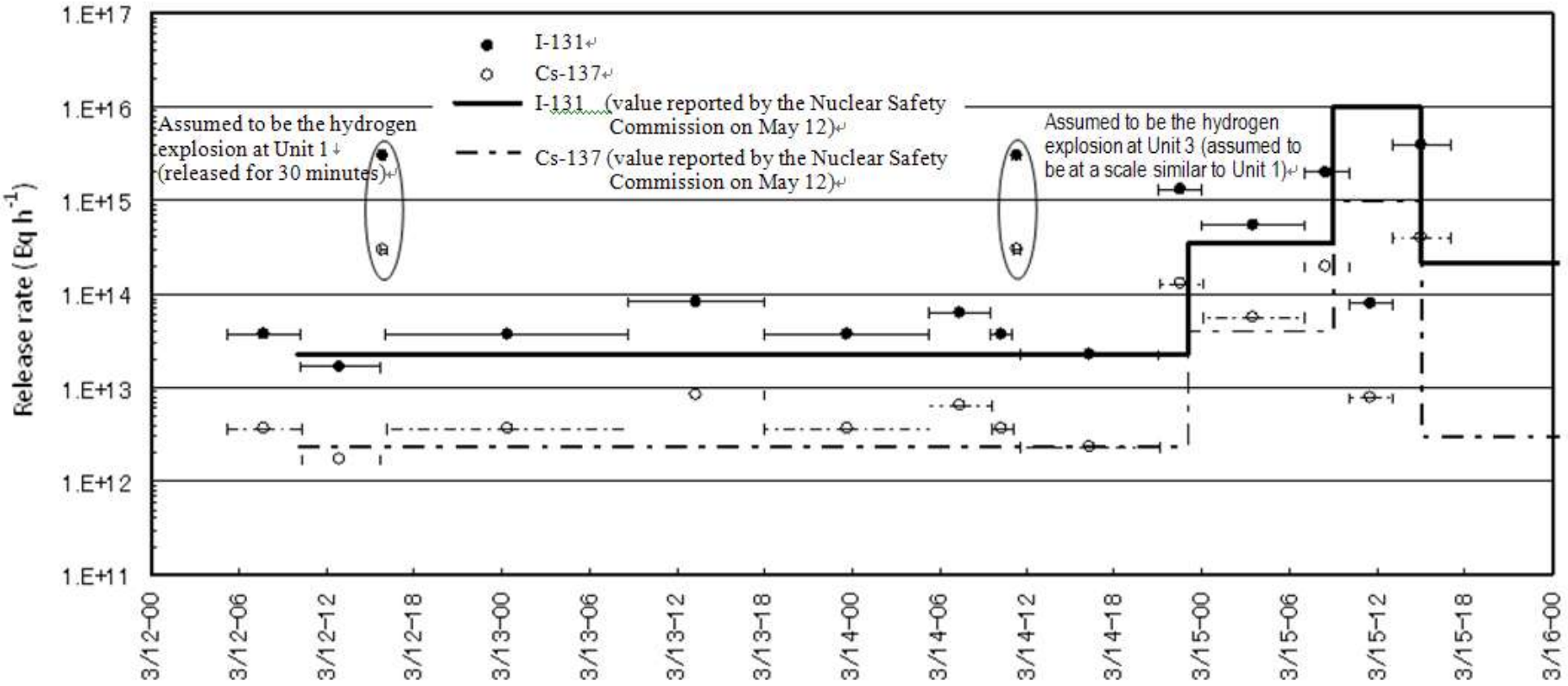


(2) Initial Release of Radioactive Materials in the Accident of Fukushima Dai-ichi NPS

Measurement Results Dose Rates by Monitoring Car at Fukushima Dai-ichi NPS



Release of Radioactive Materials: Initial Release Trends (Bq/h)



(3) The Situation of Each Unit of Fukushima Dai-ichi NPS

The Situation at Each Unit of Fukushima Dai-ichi NPS

(Field situations obtained from interviews with workers, etc.)

(1) Rubble strewn by tsunami

→ Access routes cleared to ensure fire engine access (e.g. Unit 1)

(2) Darkness

→ Work on vent valves for the primary containment vessel proceeded by torchlight (e.g. Unit 1)

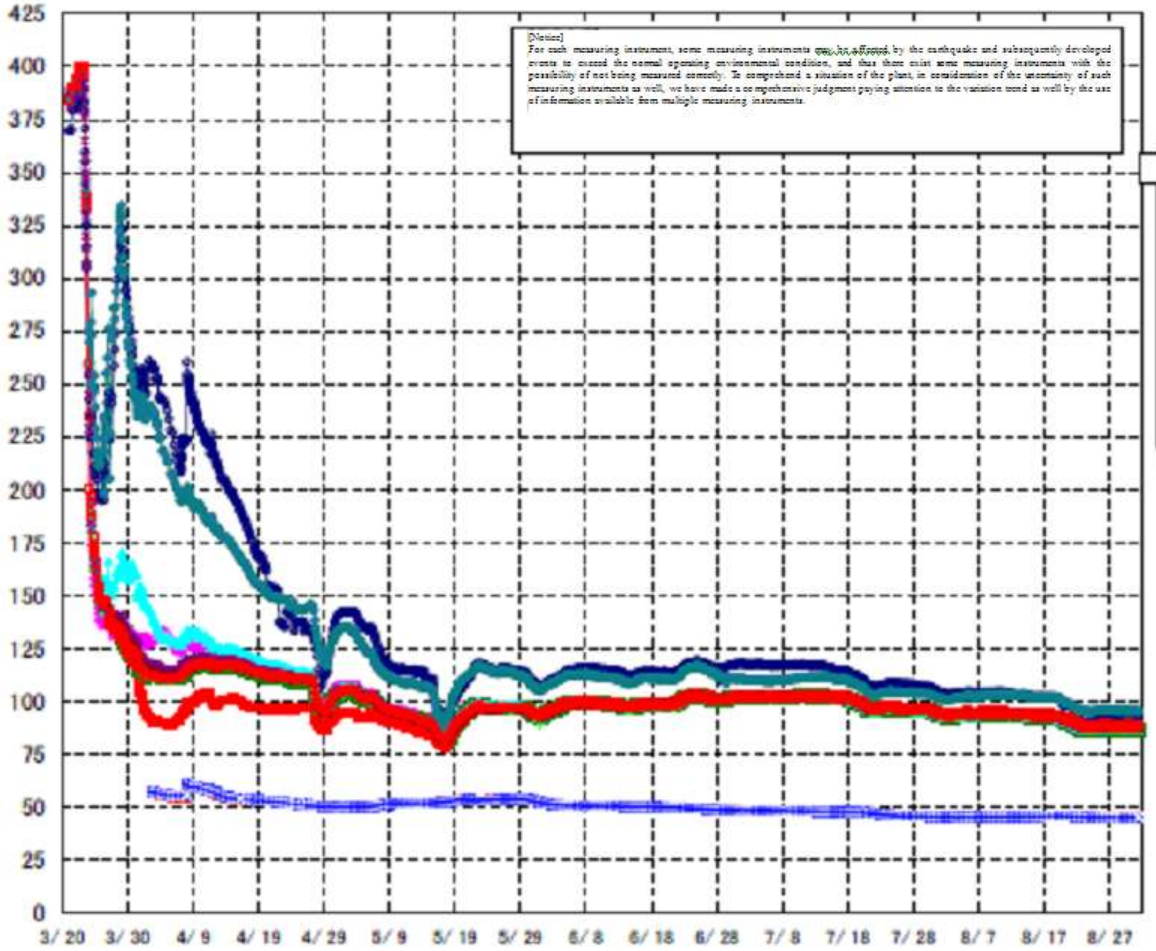
(3) Shortage of electric power

→ Car batteries from employees' cars were collected to operate valves for alternative water pumps (e.g. Unit 3)

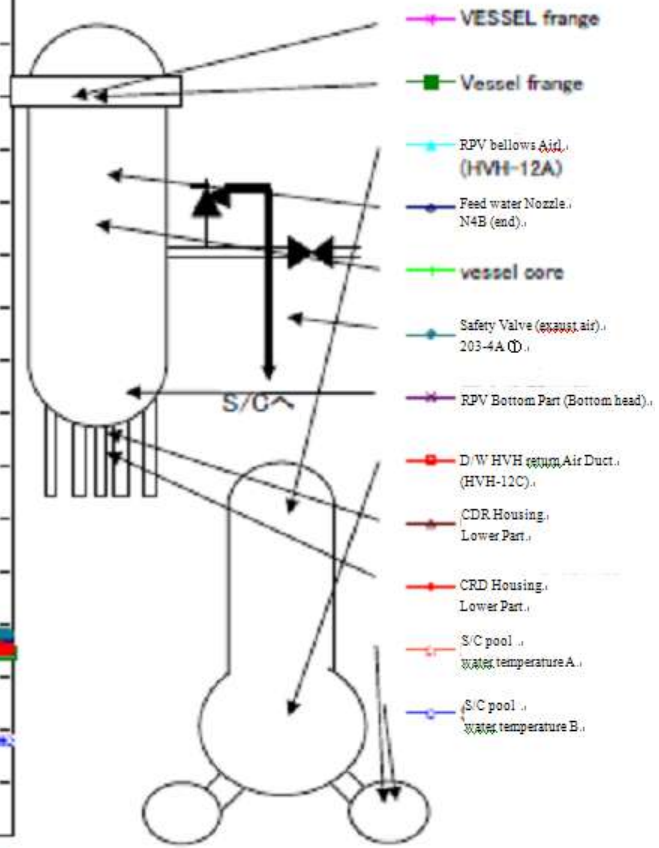
(4) Effects of hydrogen explosion

→ The initial alternative pumping lines burst, and work started on constructing new lines (e.g. Unit 2)

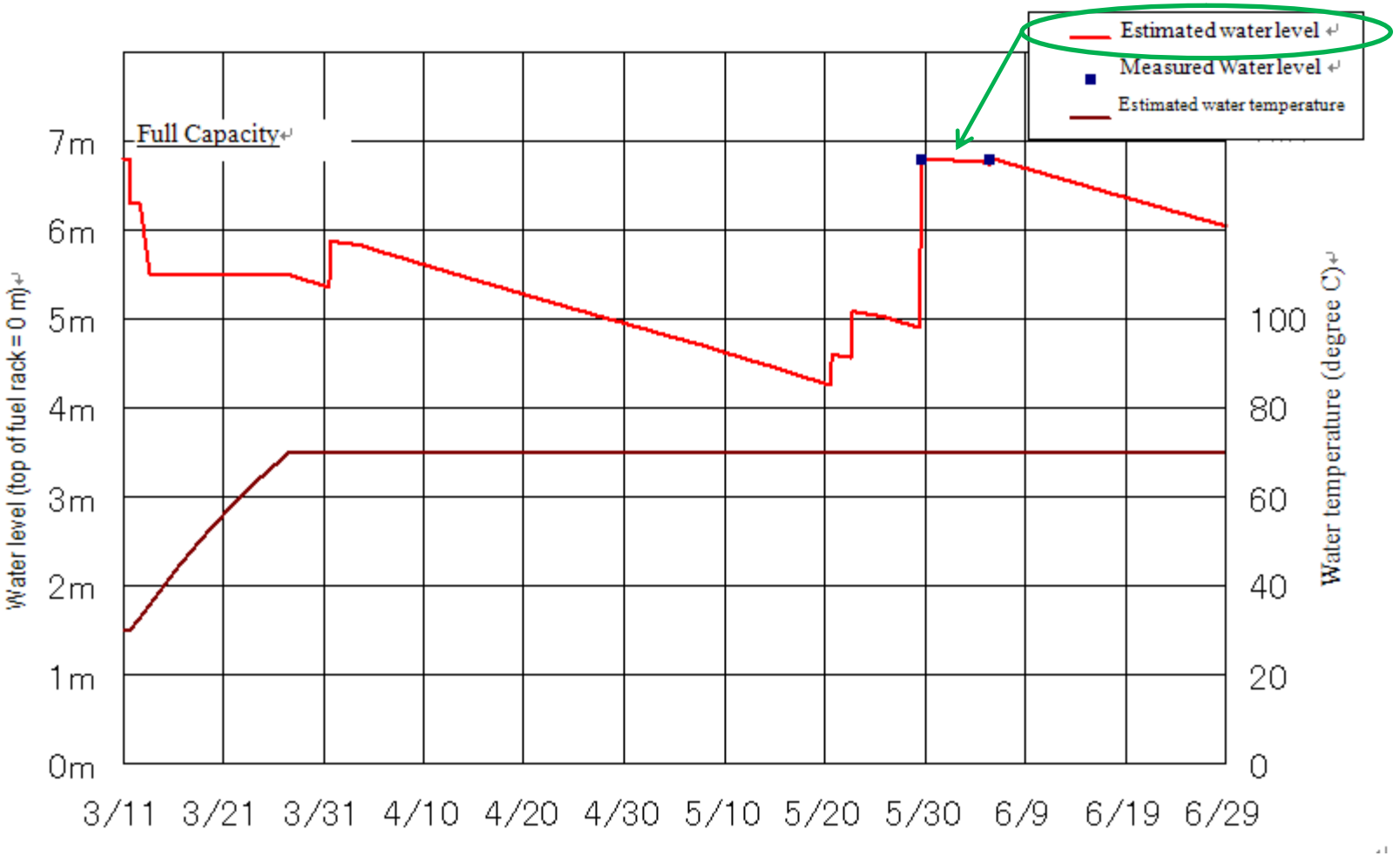
Unit 1: Reactor Pressure Vessel (RPV) Temperature Transition



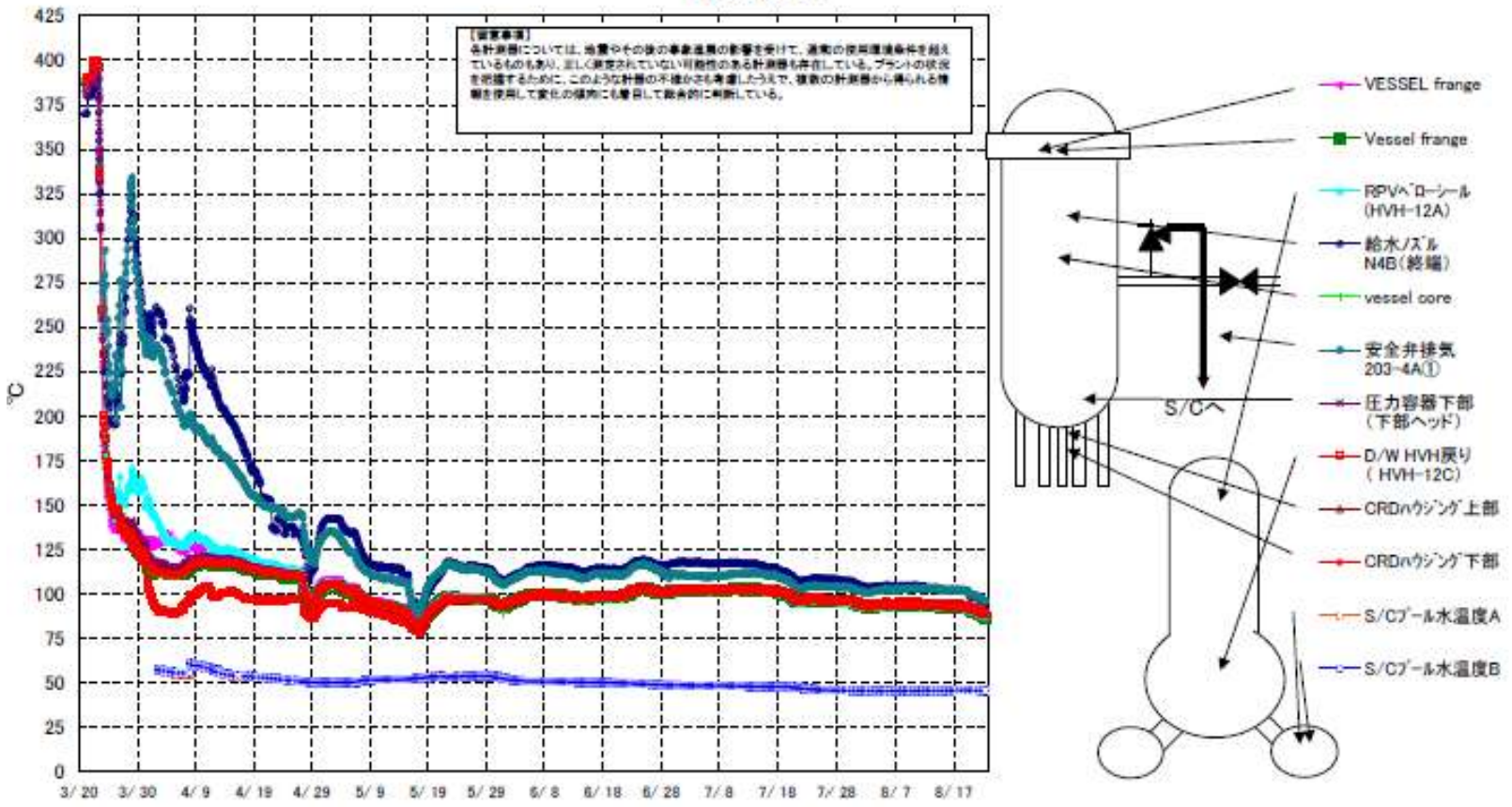
[Note]
For each measuring instrument, some measuring instruments may be affected by the earthquake and subsequently developed events to exceed the normal operating environmental condition, and thus there exist some measuring instruments with the possibility of not being measured correctly. To comprehend a situation of the plant, in consideration of the uncertainty of such measuring instruments as well, we have made a comprehensive judgment paying attention to the variation trend as well by the use of information available from multiple measuring instruments.



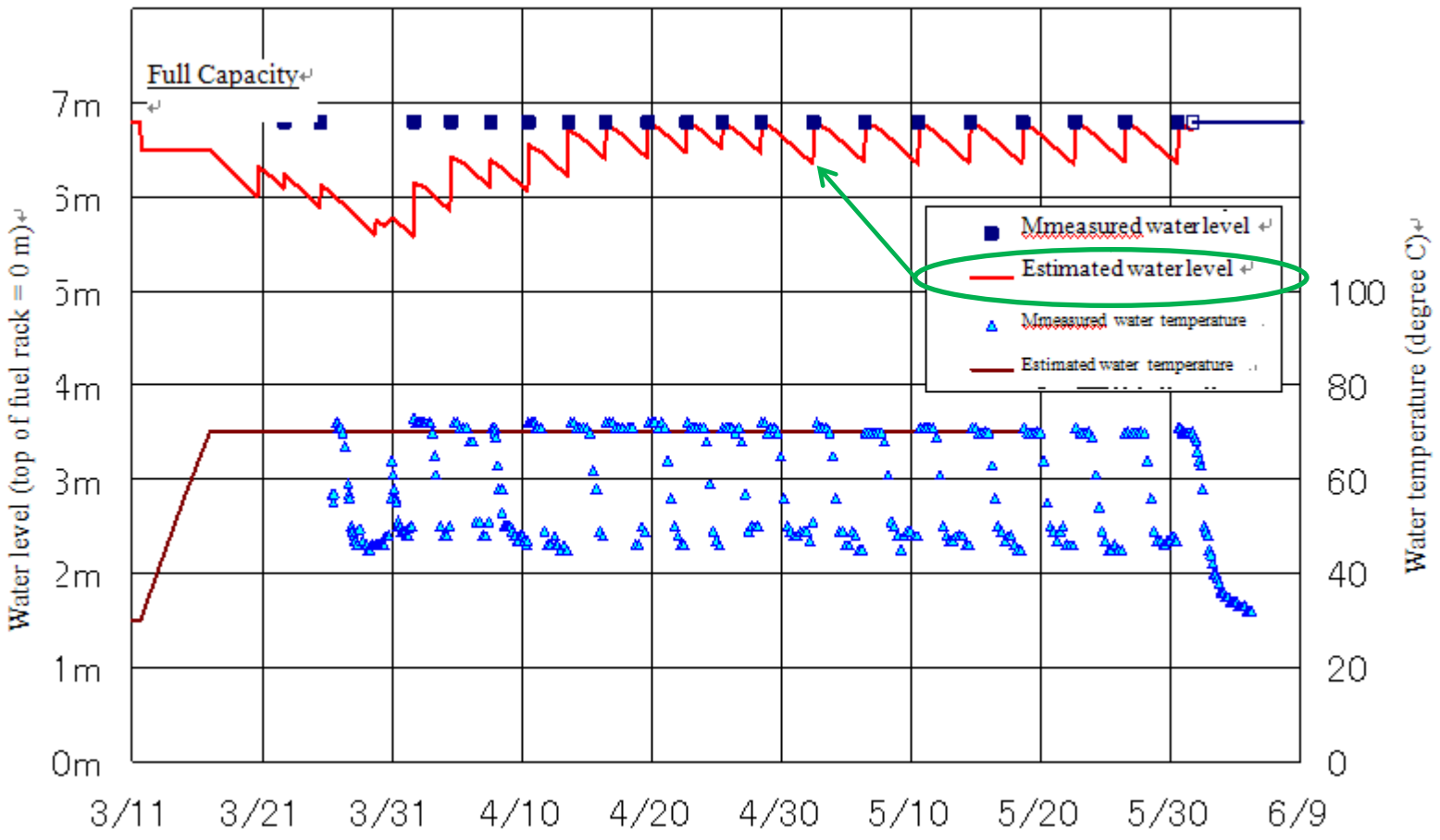
Unit 1: Spent Fuel Pool Evaluation Results



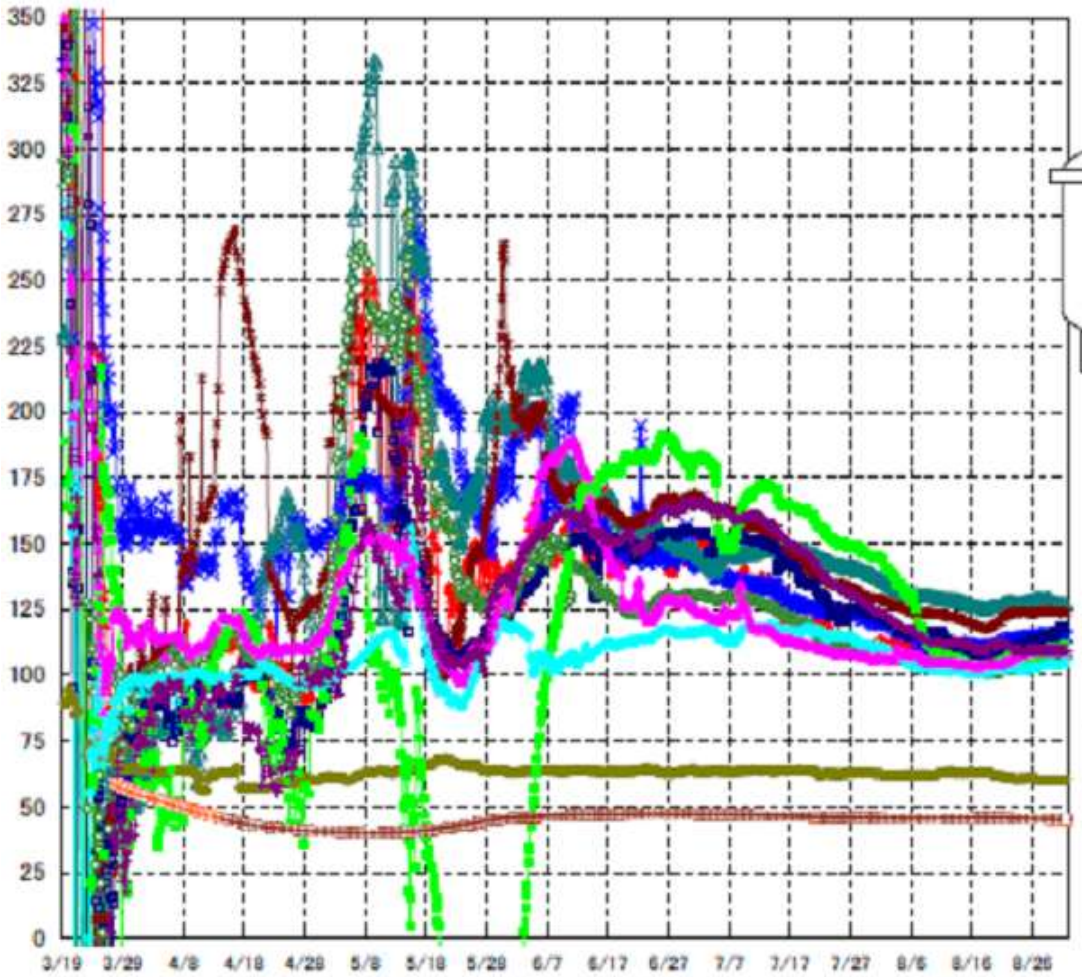
Unit 2: RPV Temperature Transition

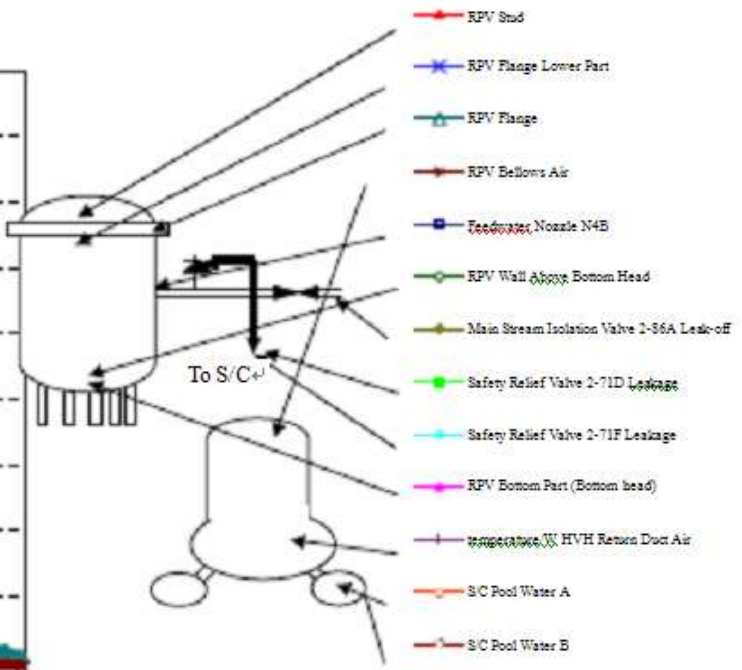


Unit 2: Spent Fuel Pool Evaluation Results



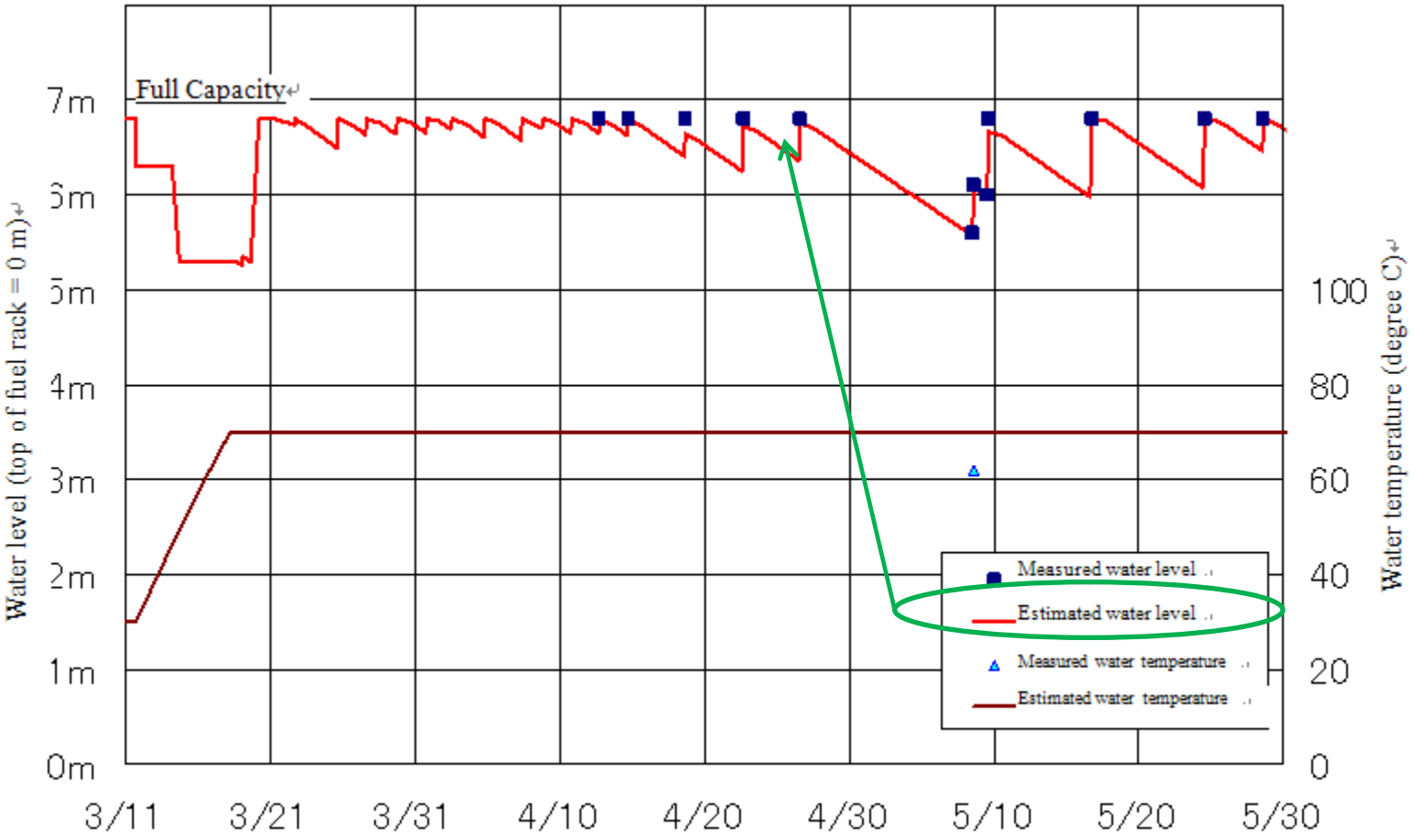
Unit 3: RPV Temperature Transition



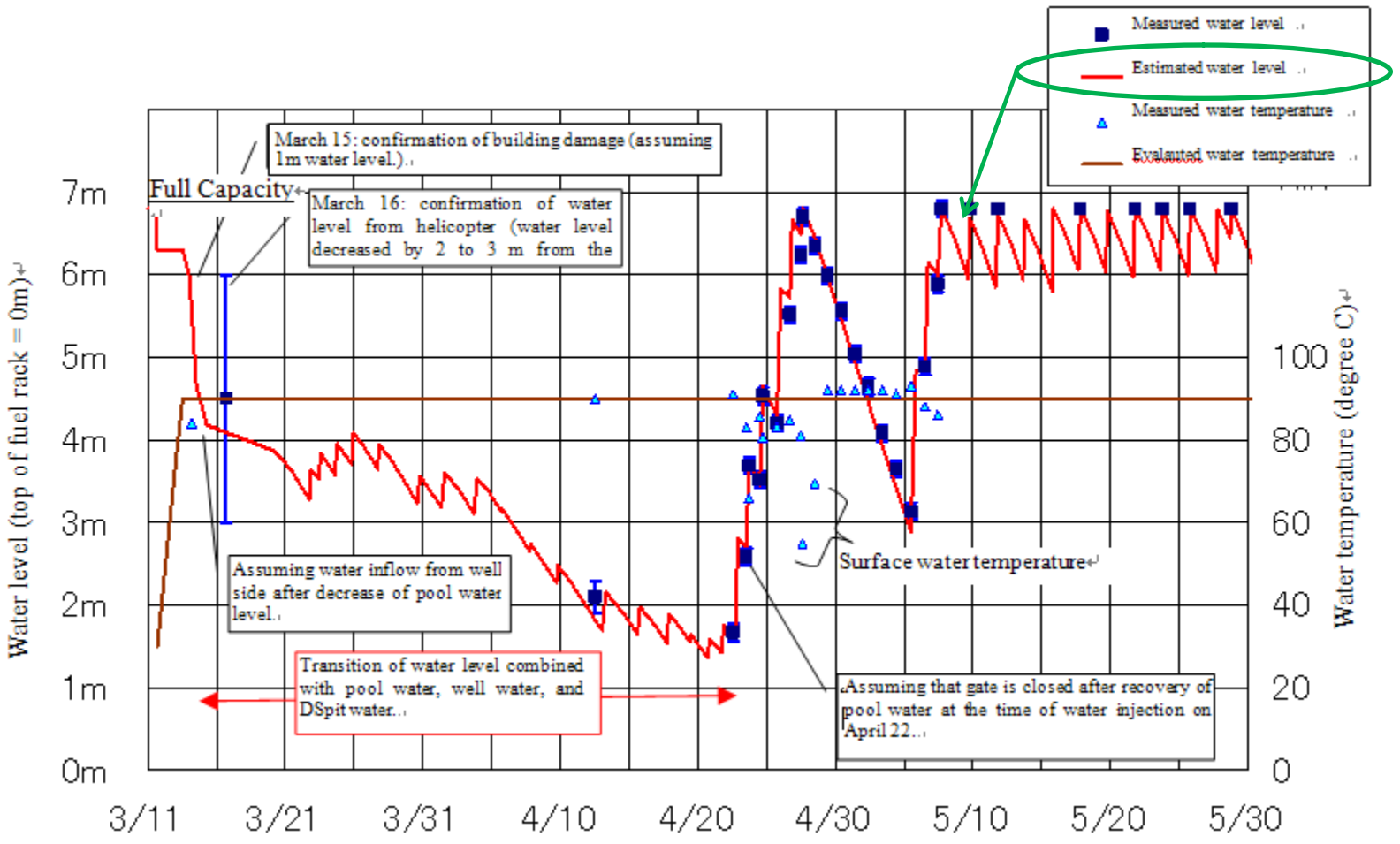


[Notice]
For each measuring instrument, some measuring instruments may be affected by the earthquake and subsequently developed events to exceed the normal operating environmental condition, and thus there exist some measuring instruments with the possibility of not being measured correctly. To comprehend a situation of the plant, in consideration of the uncertainty of such measuring instruments as well, we have made a comprehensive judgment paying attention to the variation trend as well by the use of information available from multiple measuring instruments.

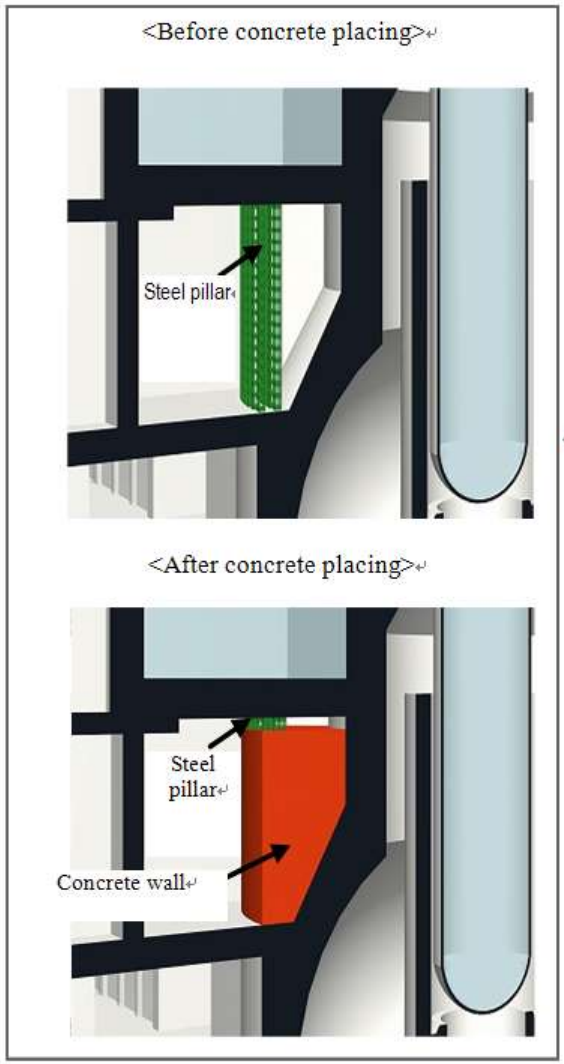
Unit 3: Spent Fuel Pool Evaluation Results

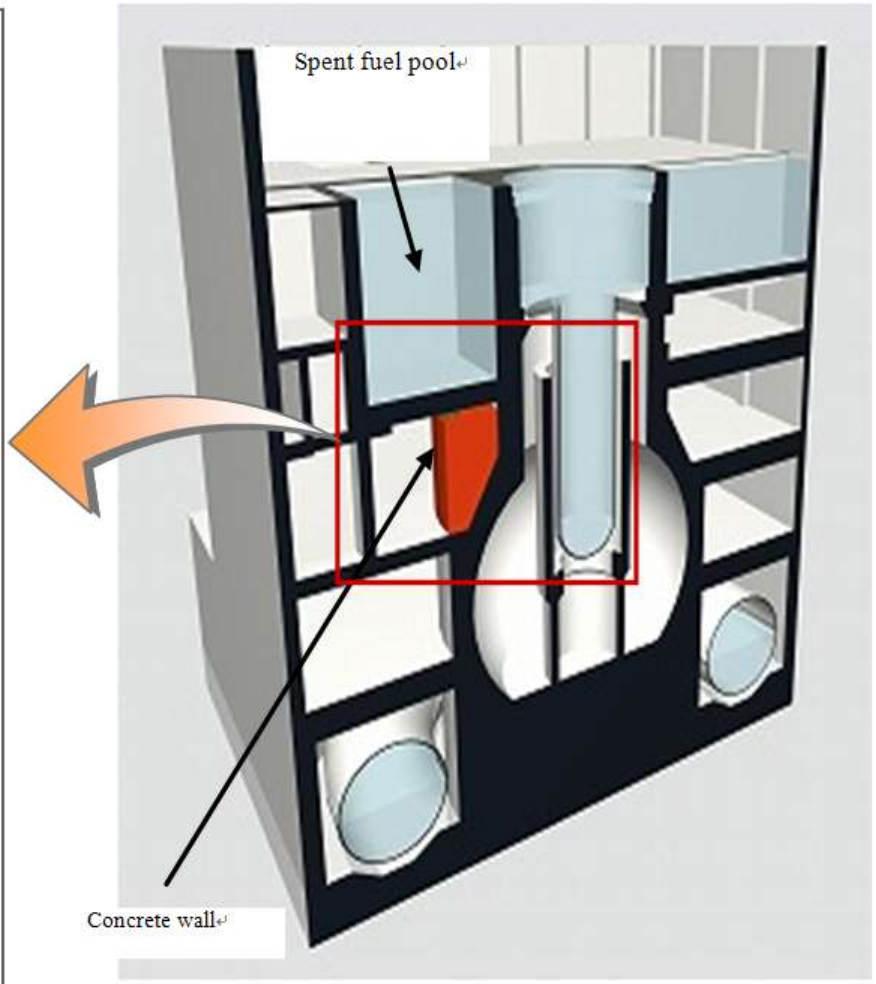


Unit 4: Spent Fuel Pool Evaluation Results



Unit 4: Installation of Support Structures at the Bottom of the Reactor Building's Spent Fuel Pool





Image

Situation at the Reactor Buildings of Fukushima Dai-ichi NPS, Units 1 to 4

Unit1 - 4

Unit4

Unit1

Unit2

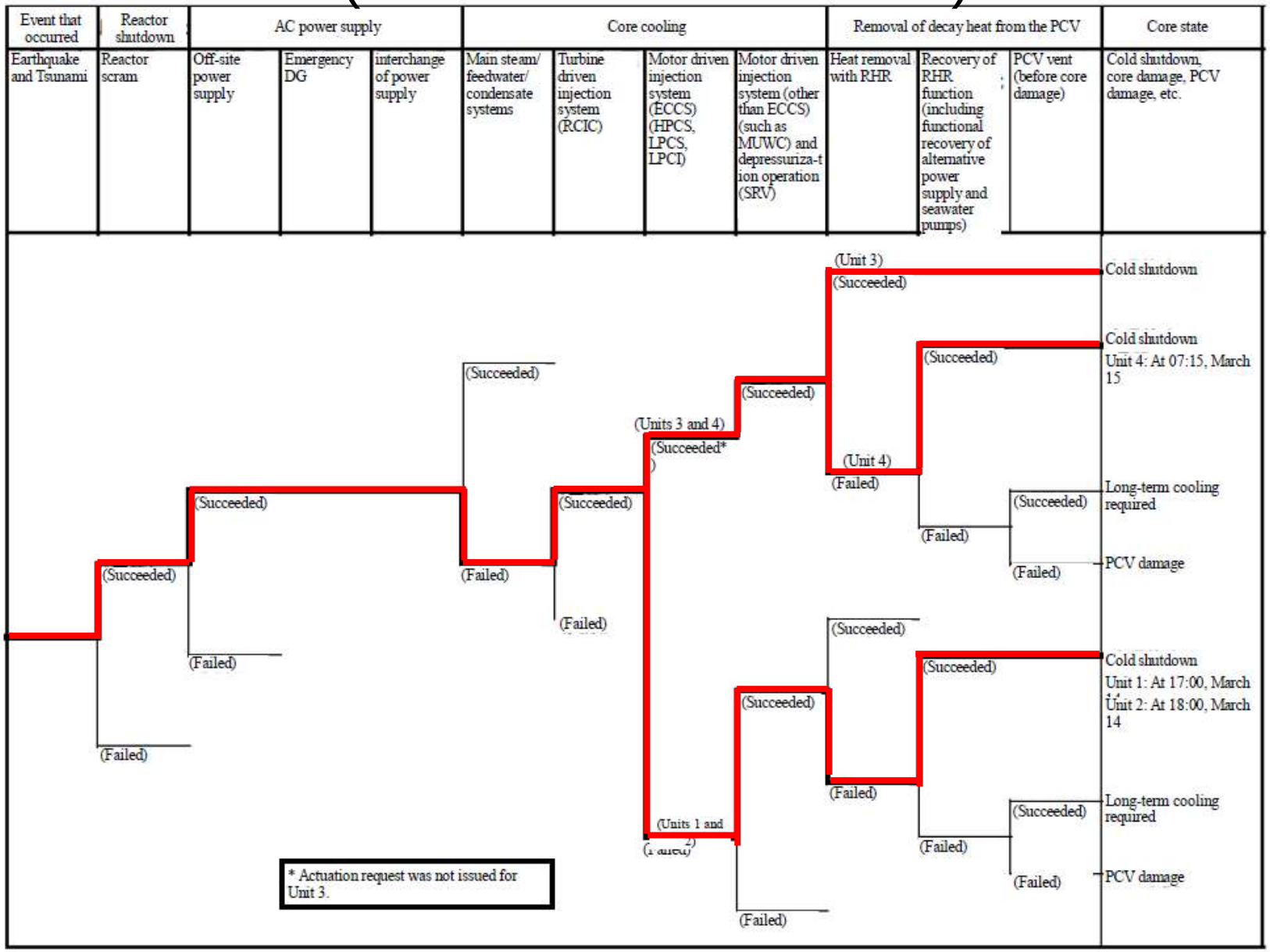
Unit3

(4) Situation of Other NPSs Affected by the Tohoku District-Off the Pacific Ocean Earthquake and the resulting tsunamis (Event Tree)

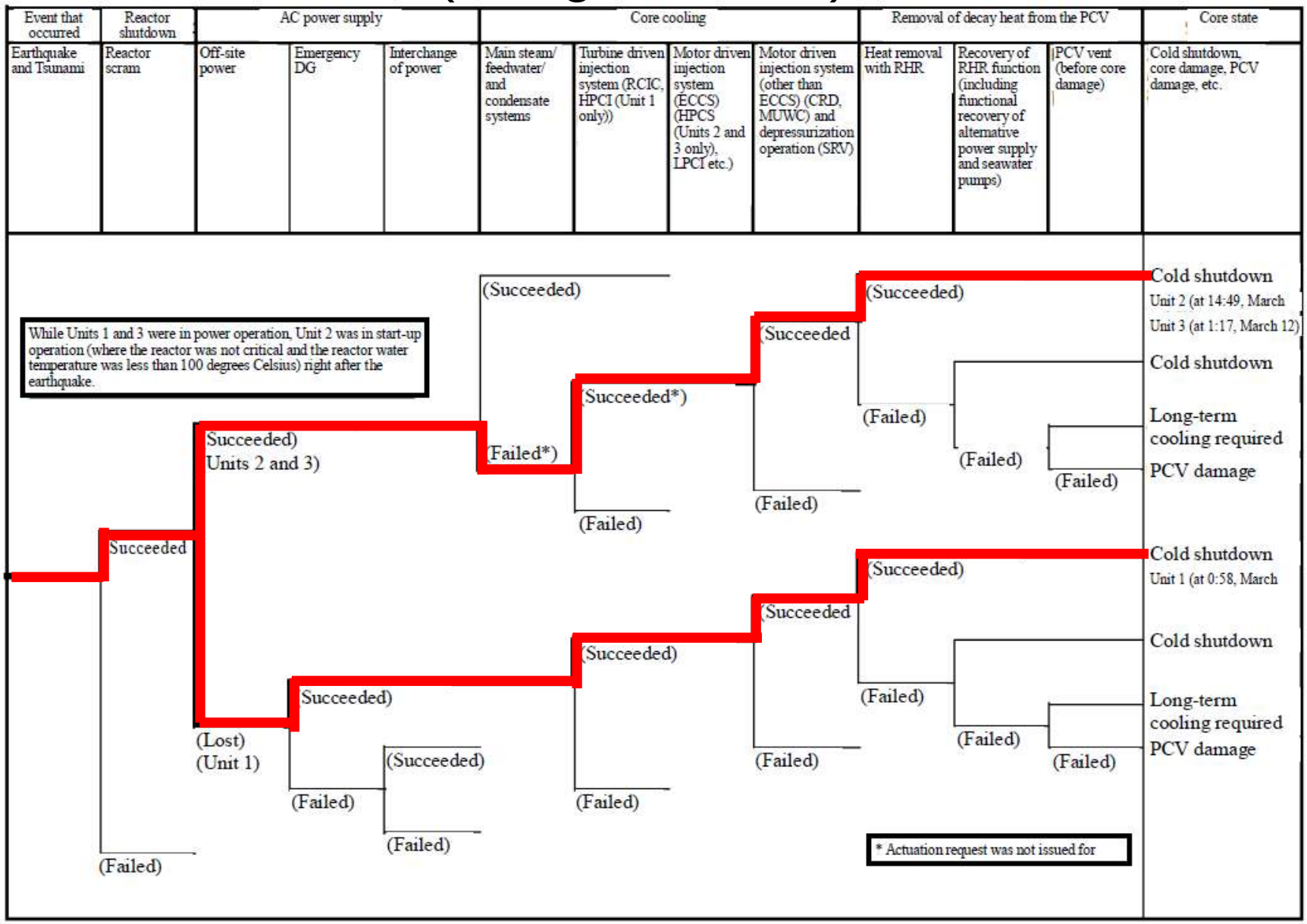
Transitional Changes in the Accident According to the Function Event Tree

No.	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬
Event	Accident	Reactor shutdown	AC power supply			Core cooling				Removal of decay heat from containment vessel			Core status
	Earthquake and tsunami	Reactor scrammed	External power	Emergency diesel generators	Power supply interchangeability	Main steam/water supply/condensation lines	Turbine-driven injection lines	Motor-driven pumps (ECCS, HPCS, LPCS, LPCI)	Motor-driven pumps (other than ECCS), (MUWC, etc.) and depressurizing operation (SRV)	Removal of heat using RHR	Restoration of RHR functions (including restoration of seawater pump functions and alternative power supply)	PCV vent (before core damaged)	Cold shutdown, core damaged, PCV damage, etc.

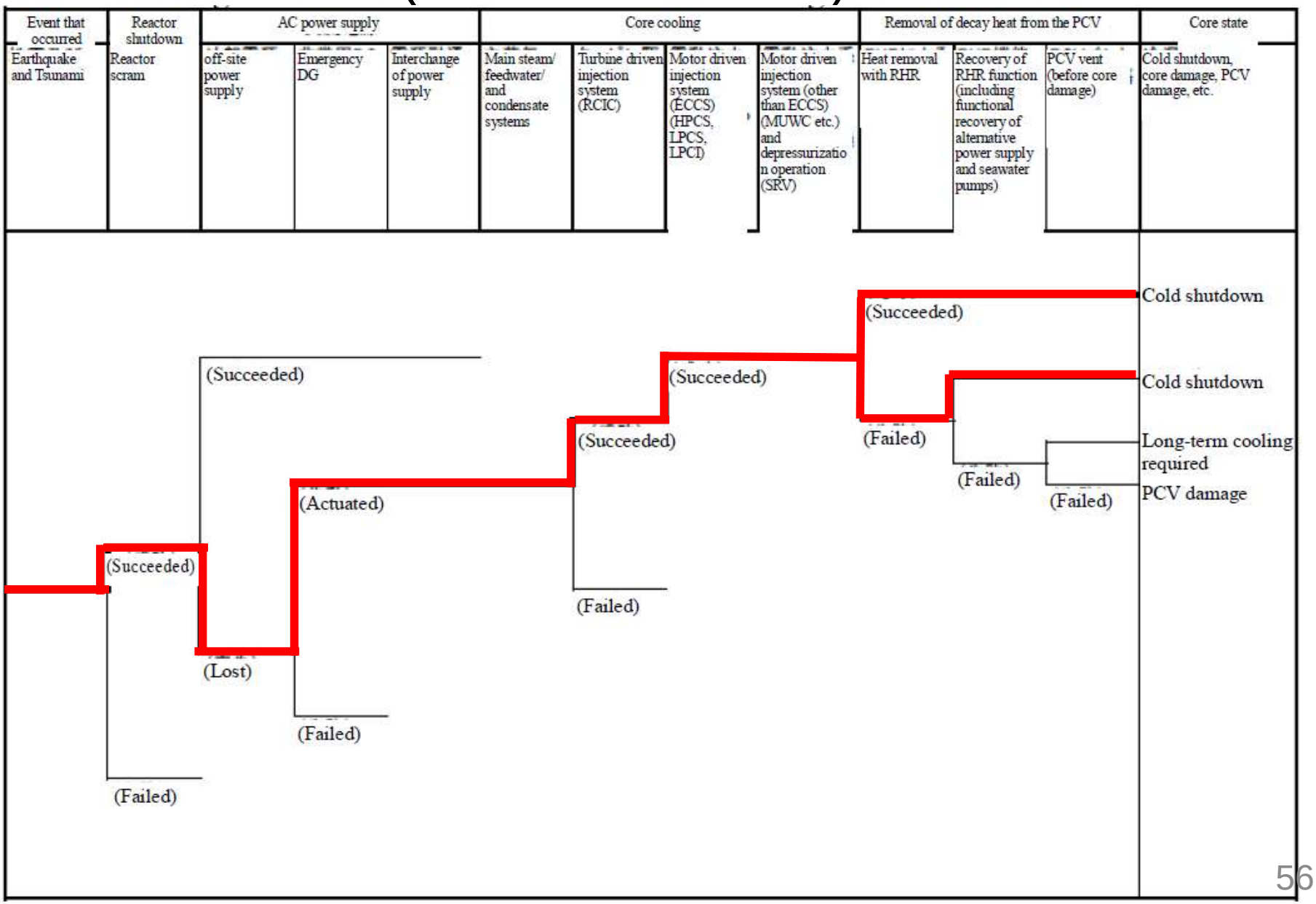
Situation Transition in the Accident at Other NPSs (Fukushima Dai-ni NPS)



Situation Transition in the Accident at Other NPSs (Onagawa NPS)



Situation Transition in the Accident at Other NPSs (Tokai Dai-ni NPS)



(5) Response regarding Evacuation Areas, etc

4. Response regarding Evacuation Areas, etc

(1) Restricted Area: On April 22, a Restricted Area was established and all access to the area was prohibited. Now, temporary access is allowed for residents and those acting in the public interest.

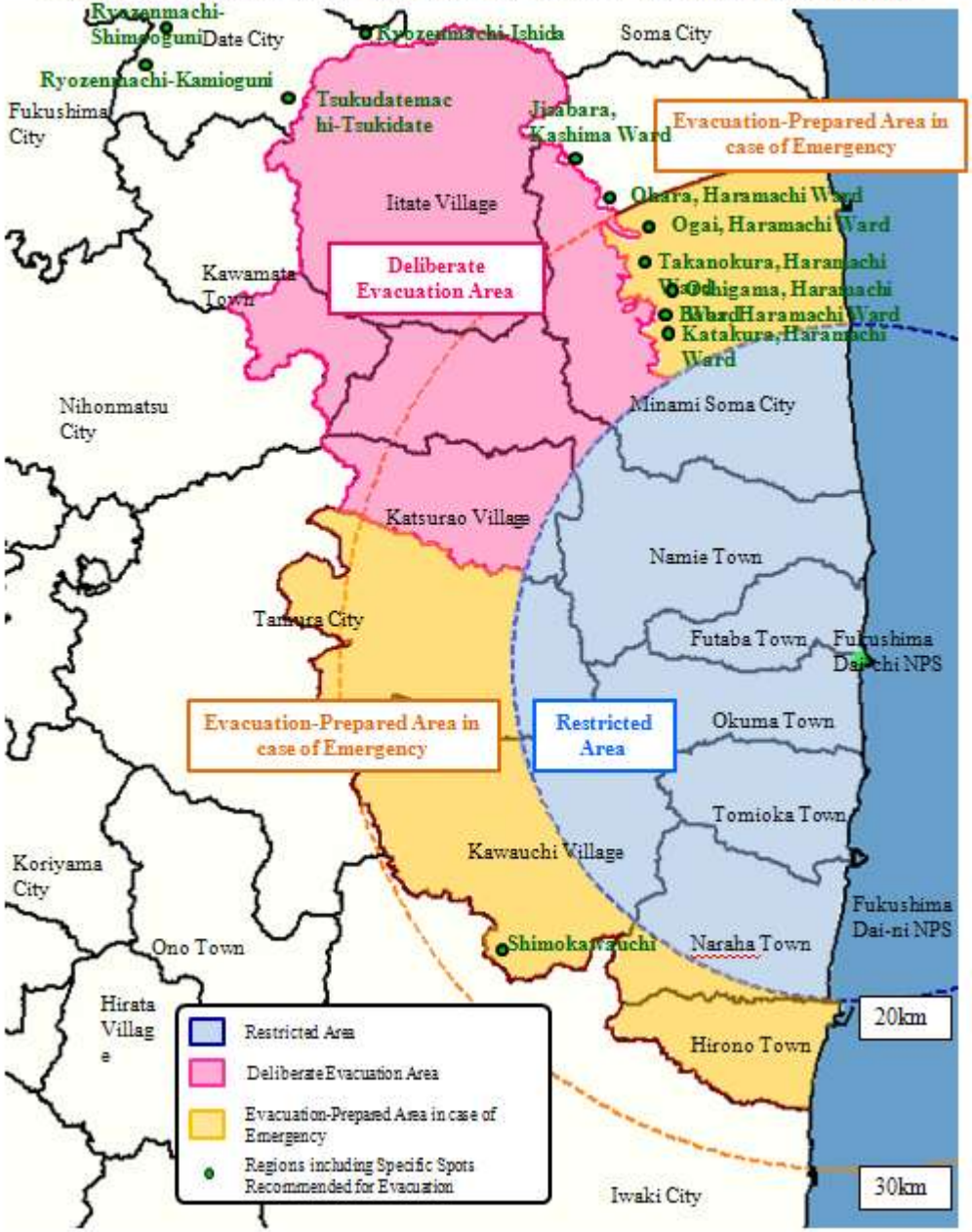
(2) Deliberate Evacuation Areas: On April 22, Deliberate Evacuation Areas were established in areas where dose was increasing. Most residents had already evacuated.

(3) Evacuation-prepared Areas in Case of Emergency: On April 22, areas for which preparations must be made to evacuate in the event of an emergency were established for those areas where such preparation was required. Now, efforts to lift such restrictions are actively being made.

(4) Specific Areas Recommended for Evacuation: In June, Specific Areas Recommended for Evacuation were established for areas with high dose. The number of such areas is currently 227 (245 households).

Map of Restricted Area, Deliberate Evacuation Areas, Evacuation-prepared Areas in Case of Emergency, Specific Areas Recommended for Evacuation

(As of August 3, 2011)



(6) Measures to Address Agricultural Products, etc.

7. Measures to Address Agricultural Products, etc. (Provisional Regulatory Values)

Nuclide	Provisional regulation values of radioactive materials in food in accordance with the Food Sanitation Act (Bq/kg)	
Radioactive iodine (Representative radio-nuclides among mixed radio-nuclides: ^{131}I)	Drinking water	300
	Milk, dairy products*	
	Vegetables (Except root vegetables and tubers)	2,000
	Fishery products	
Radioactive cesium	Drinking water	200
	Milk, dairy products	
	Vegetables	500
	Grains	
	Meat, eggs, fish, etc.	
Uranium	Infant foods	20
	Drinking water	
	Milk, dairy products	
	Vegetables	100
	Grains	
	Meat, eggs, fish, etc.	
Alpha-emitting nuclides of plutonium and transuranic elements (Total radioactive concentration of ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{242}Pu, ^{241}Am, ^{242}Cm, ^{243}Cm, ^{244}Cm)	Infant foods	1
	Drinking water	
	Milk, dairy products	
	Vegetables	10
	Grains	
	Meat, eggs, fish etc.	

*) 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.

Measures to Address Agricultural Products, etc. : Individual Items

(1) Tea: Tea, which appears to have a large amount of radioactive cesium, is “deeply cropped.”

(2) Beef: There was some beef from cattle which appear to have eaten straw containing radioactive cesium. After this discovery, information calling for attention while handling rice straw was distributed.

(3) Rice: In areas with high concentrations of radioactive cesium in the soil, a preliminary survey was implemented in the step before harvesting. The concentration measurements after harvesting are planned based on the survey results. No radioactive materials exceeding the provisional regulatory values have been detected (as of August 31).