The 2011 Tohoku Pacific Earthquake and Current Status of Nuclear Power Stations

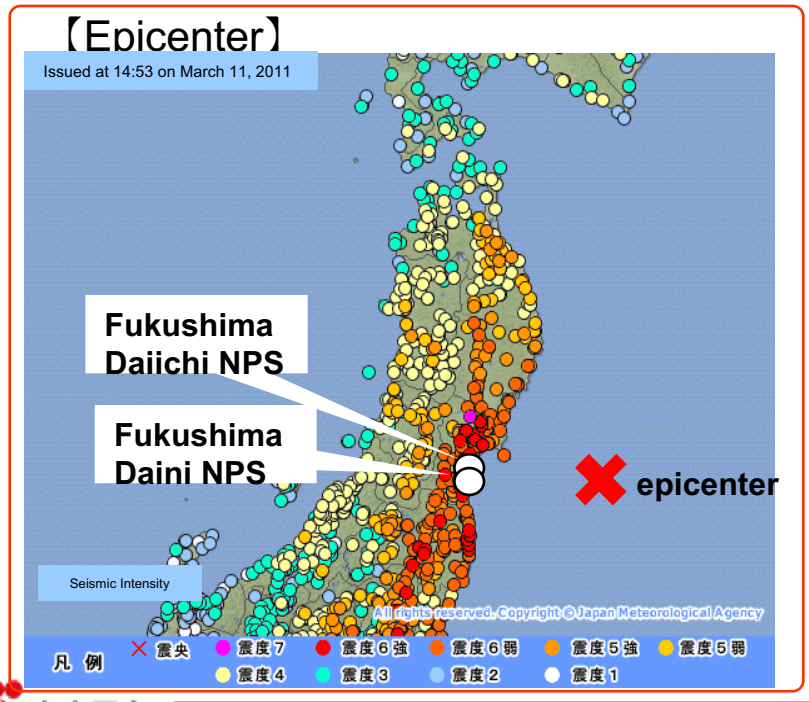
March 31, 2011

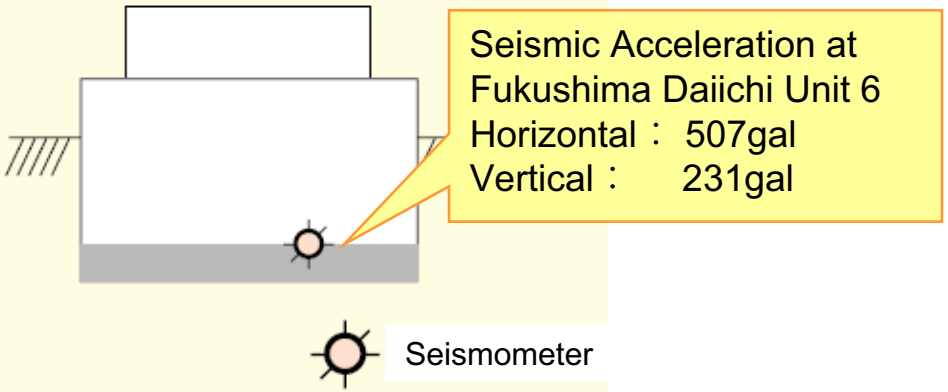
Tokyo Electric Power Company

東京電力 TEPCO

Tohoku Pacific Ocean Earthquake

- **Time:** 2:46 pm on Fri, March 11, 2011.
- **Place:** Offshore Sanriku coast (northern latitude of 38 degrees, east longitude of 142.9), 10km in depth, Magnitude 9.0
- **Intensity:** **Level 7** at Northern Miyagi prefecture
  Upper 6 at Naraha, Okuma, and Fudaba, Fukushima pref. (Nuclear Power Station)
  Lower 6 at Ishinomaki, Onagawa, Tokai in Miyagi pref.
  Lower 5 at Kariwa, Nigata pref.
  4 at Rokkasho, Higashidori in Aomori pref., Kashiwazaki, Niigata pref.

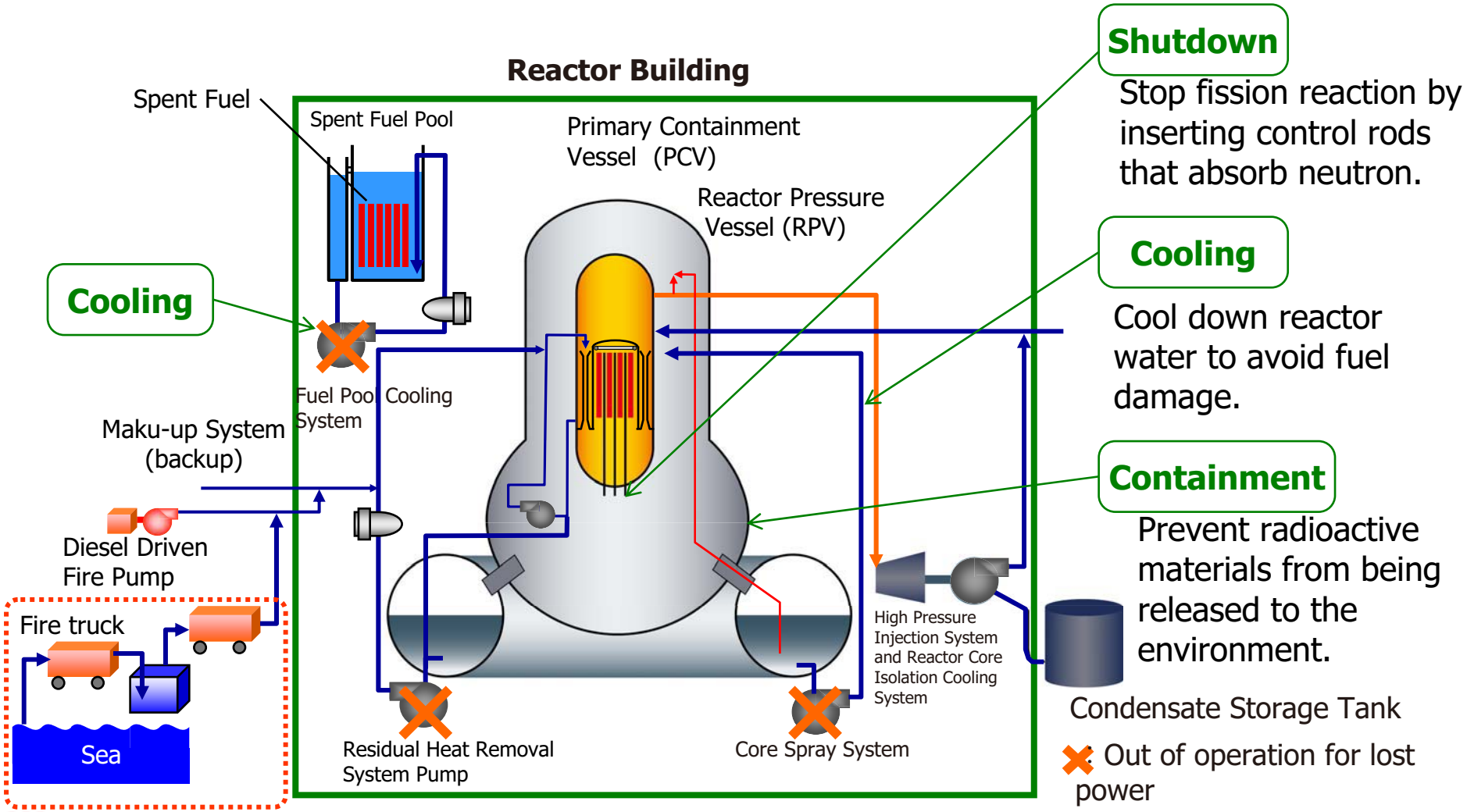




* gal: a unit of acceleration defined as cm/s².

This Accident Description: Fukushima Daiichi

- All operating Units automatically shutdown. Offsite Power Supply lost by the quake (1F1-6)
- Diesel Generators started, however Tsunami's wave flooded all DGs but one at 1F6
- Seawater Pumps failed due to the Tsunami (1F1-6)



Plant Status: Fukushima Daiichi

- Unit1-3: Automatic Shutdown
- Unit1-4: Offsite Power Lost due to earthquake. Diesel Generators started, however lost by Tsunami's wave
- Unit 1-3: Core Cooling System failed, Water injected via Fire Protection Lines. Water level reduced below the Top of Fuel. Unit 5-6: Core Cooling system was recovered
- Unit 1-4 Spent Fuel Pool: Seawater injected by Fire Engines external pumps. Unit2:from 3/17 fire truck pumps were injecting seawater, expanded to Unit 3 and 4 on 3/20
- Unit1,3 and 4: Hydrogen explosion caused the upper half of R/B damage. Unit2 may be damaged by Suppression chamber.
- Unit1-3 emitted radioactive substances during Venting to reduce inner pressure of the Reactor Pressure Vessel

As of 31 March

			#1	#2	#3	#4	#5	#6
	Pre-Earthquake Status		**Operating**			**Shutdown for Maintenance**		
After Earthquake	**Shutdown**		**○ Automatic Shutdown**			—	—	—
	Cooling	**Reactor**	△ Offsite Power Freshwater	△ Offsite Power Freshwater	△ Offsite Power Freshwater	— Offsite Power Shutdown	○ Cold Shutdown	○ Cold Shutdown
		Pool	△	△	△	△	○	○
	Containment		Reactor Building damaged	One Blowout Panel opened	Reactor Building damaged	Reactor Building damaged	Drilled holes on the roof of Reactor Building	Drilled holes on the roof of Reactor Building

○ :functioning △: non-functioning(working progress) ×:non-functioning (not working)

Plant Status: Fukushima Daini

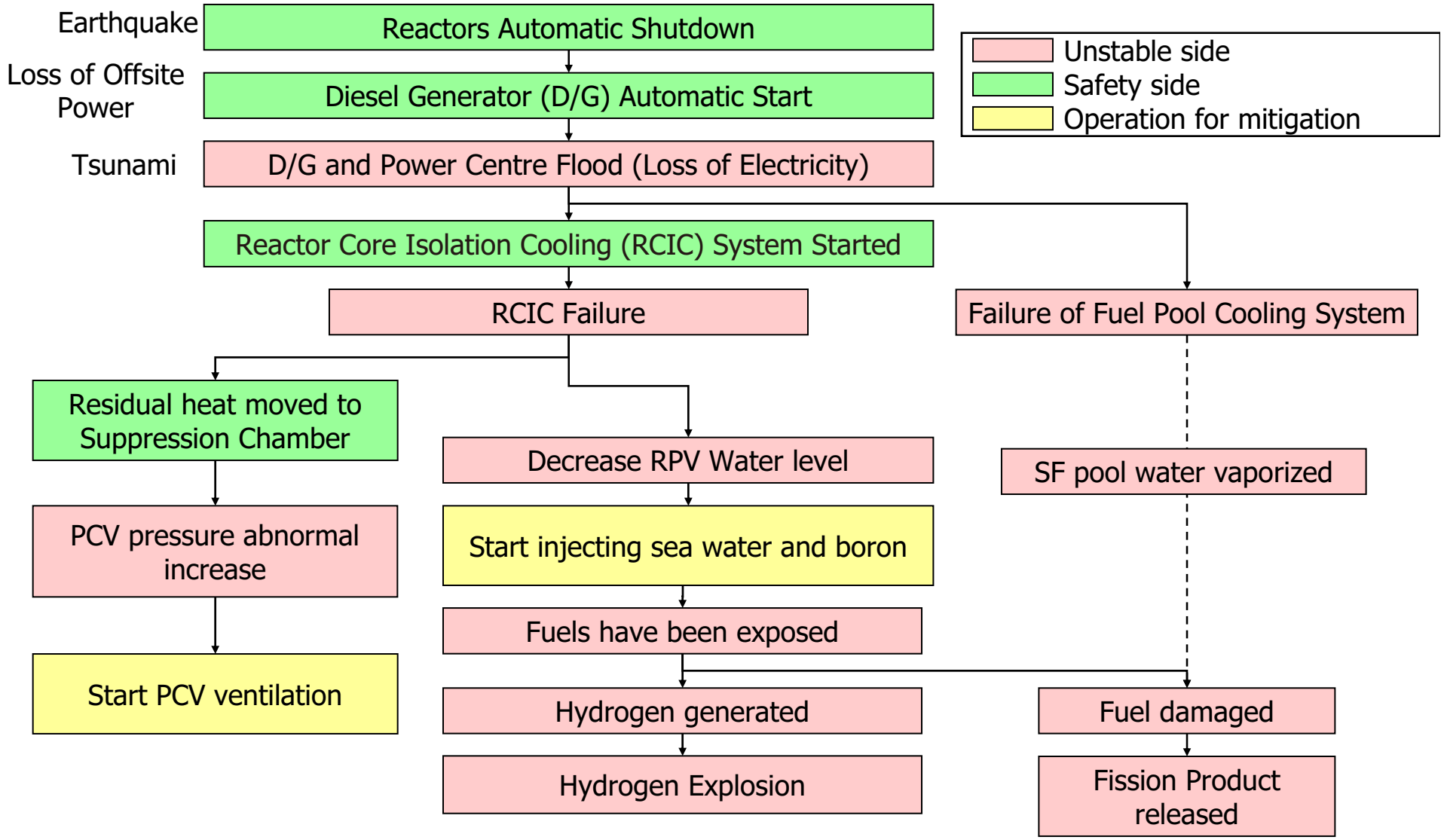
- Unit1-3: Automatic Shutdown. Unit 4-6: Units in extended outage
- Unit1-4: Offsite Power maintained. Diesel Generators lost by the Tsunami flooding
- Unit 3: Cold Shut down in 22hrs after the quake
- Unit 1,2 and 4: Core Cooling system recovered and successfully to achieve Cold Shutdown

As of 31 March

		Fukushima Daini Nuclear Power Station			
		Unit 1	**Unit 2**	**Unit 3**	**Unit 4**
Before Earthquake	**Status**	**Operating**			
After Earthquake	**Shut down**	○			
	Cooling	○ **(Cold Shutdown)**			
	Containment	○			

○ :functioning △: non-functioning (working progress) ×:non-functioning (not working)

Course of Events（Fukushima Daiichi Unit 3）



Chronology of Fuel Cooling

SF Pool | Reactor | Power Supply

March 11,	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5-6	Common SF Pool
14:46	**Earthquake**					
12th	12 Start injecting sea water		13Start injecting sea water		One D／G survived	
13th		14Start injecting sea water				
14th						
17th		17 Water spray into spent fuel pool				
20th		20 Seawater injection into spent fuel pool	20Water spray into spent fuel pool	20Water spray into spent fuel pool	20 Reactor cooling shutdown	
21th						21water injection into spent fuel pool
22th	20 Recovered power to power center from offsite		22 Received power to power center from offsite		20～21 Switched from D/G to offsite power	
23th	24Recover Main Control Room lighting		22Recover Main Control Room lighting			24Received electricity from offsite
24th	25 Change over from seawater to fresh water		23 Seawater injection into spent fuel pool	25 Seawater injection into spent fuel pool		24Start cooling
25th		26Recover Main Control Room lighting	25Change over from seawater to fresh water			
26th		26Change over from seawater to fresh water				
27th				29Recover Main Control Room lighting		
31st	31Water spray into spent fuel pool					
Reactor water temp：	N.D.	N.D.	N.D.	No fuel	47.4℃, 21.4℃	
SF Pool Temp：	N.D.	45℃	N.D.	N.D.	30.6℃, 27.0℃	32℃

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Plant Parameters (Fukushima Daiichi) as of March 31 14:00

Reactor Pressure [MPag]

Unit1	Unit 2	Unit 3
0.506	-0.011	0.016

FPC Skimmer Surge Tank level [mm]

Unit1	Unit 2	Unit 3	Unit 4
4,500	5,600	N.D.	5,200

RPV Temp [℃]

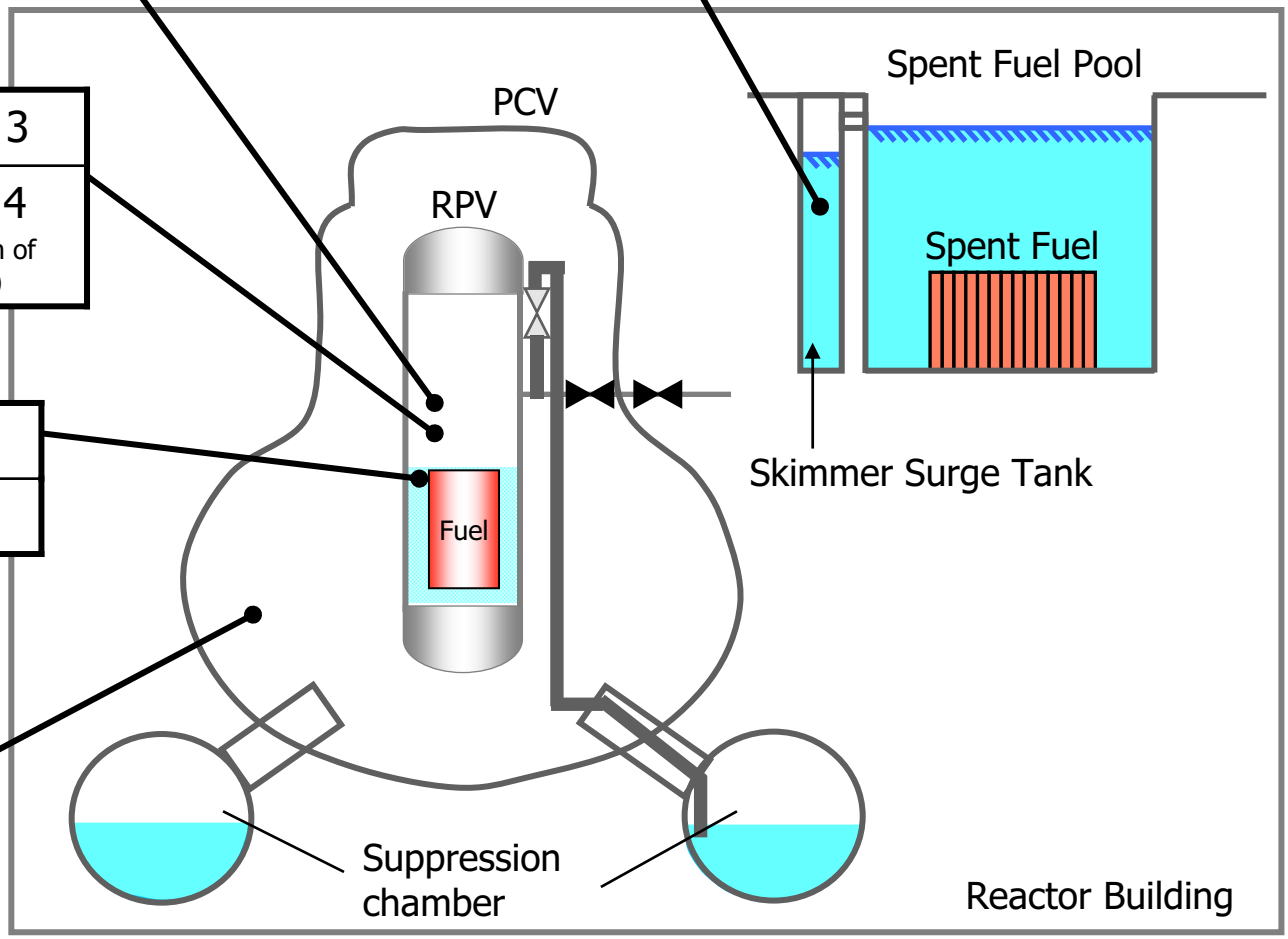
Unit1	Unit 2	Unit 3
246.1 (Feedwater Nozzle)	172.4 (Feedwater Nozzle)	114.4 (bottom of RPV)

Reactor water level [mm]

Unit1	Unit 2	Unit 3
-1,650	-1,500	-2,250

Drywell pressure [MPaabs]

Unit1	Unit 2	Unit 3
0.210	0.110	0.1066



Evacuation

Fri 11 March

14:46 Automatic Shutdown
19:03 Emergency Announcement (Daiichi) by the Gov't
21:23 3 km radius evacuation order and 10 km radius citizens take shelter directed by the PM

Sat 12 March

5:44 10 km radius evacuation directed by the PM
7:45 Emergency Announcement (Daini) by the Gov't
3 km radius evacuation and 10 km radius (Daini) taking shelter directed by the PM
17:39 10 km radius evacuation (Daini) directed by the PM
18:25 20 km radius evacuation (Daiichi) directed by the PM

Tue 15 March

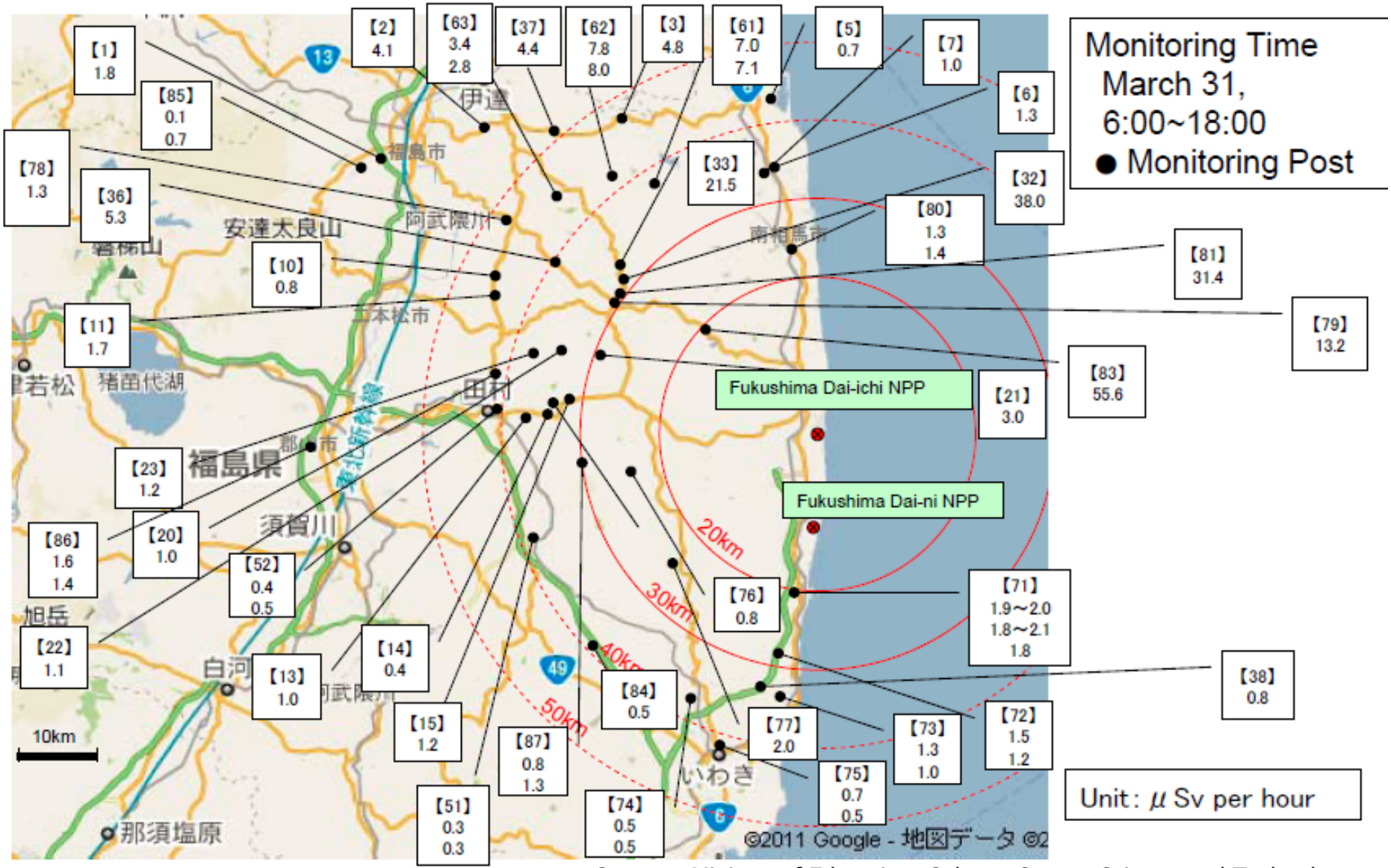
11:00 20-30 km radius taking shelter (Daiichi) directed by the PM

Fri 25 March

am 20-30 km radius evacuation (Daiichi) recommended by the Chief Cabinet Secretary

Monitoring Data

Readings at Monitoring Post out of Fukushima Dai-ichi NPP



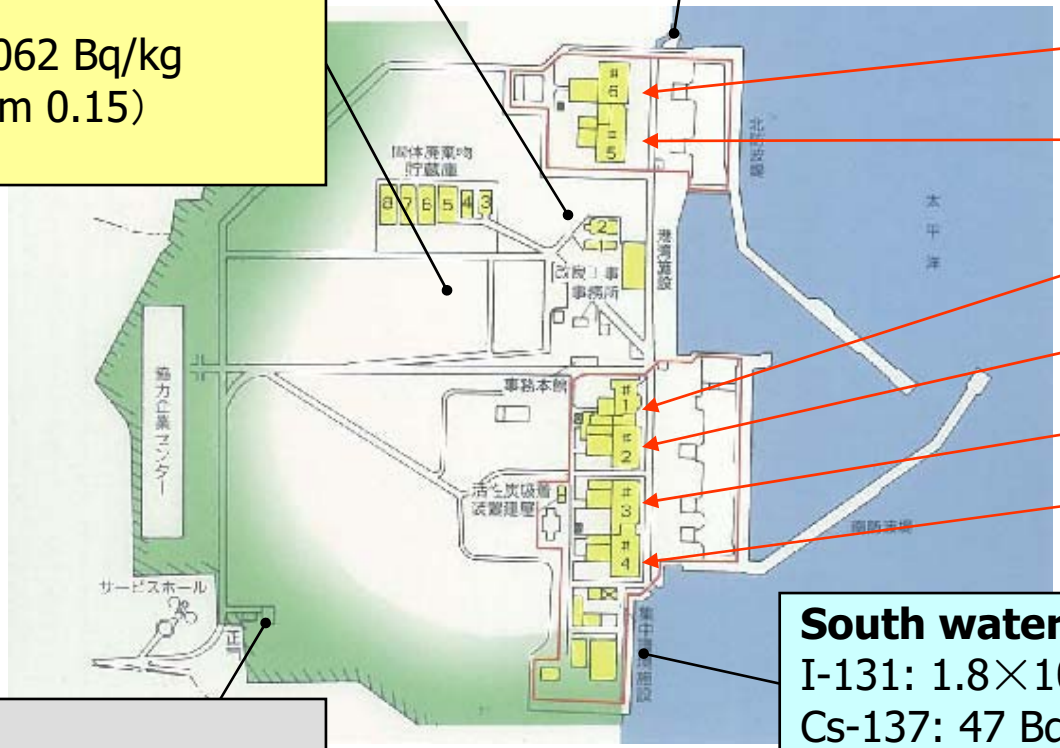
Source: Ministry of Education, Culture, Sports, Science and Technology

Monitoring Data inside the Site Boundary

Solid Waste Storage Building
Pu-238: 0.18±0.033 Bq/kg
（Normal: Maximum 0.15）
as of 3/22 7:45

Sports Ground
Pu-238: 0.54±0.062 Bq/kg
（Normal: Maximum 0.15）
as of 3/21 13:30

North of #5-#6water Outlet
I-131: 47 Bq/cm^3 (X1177.3)
Cs-137: 12 Bq/cm^3 (X137.9)
as of3/30 14:15



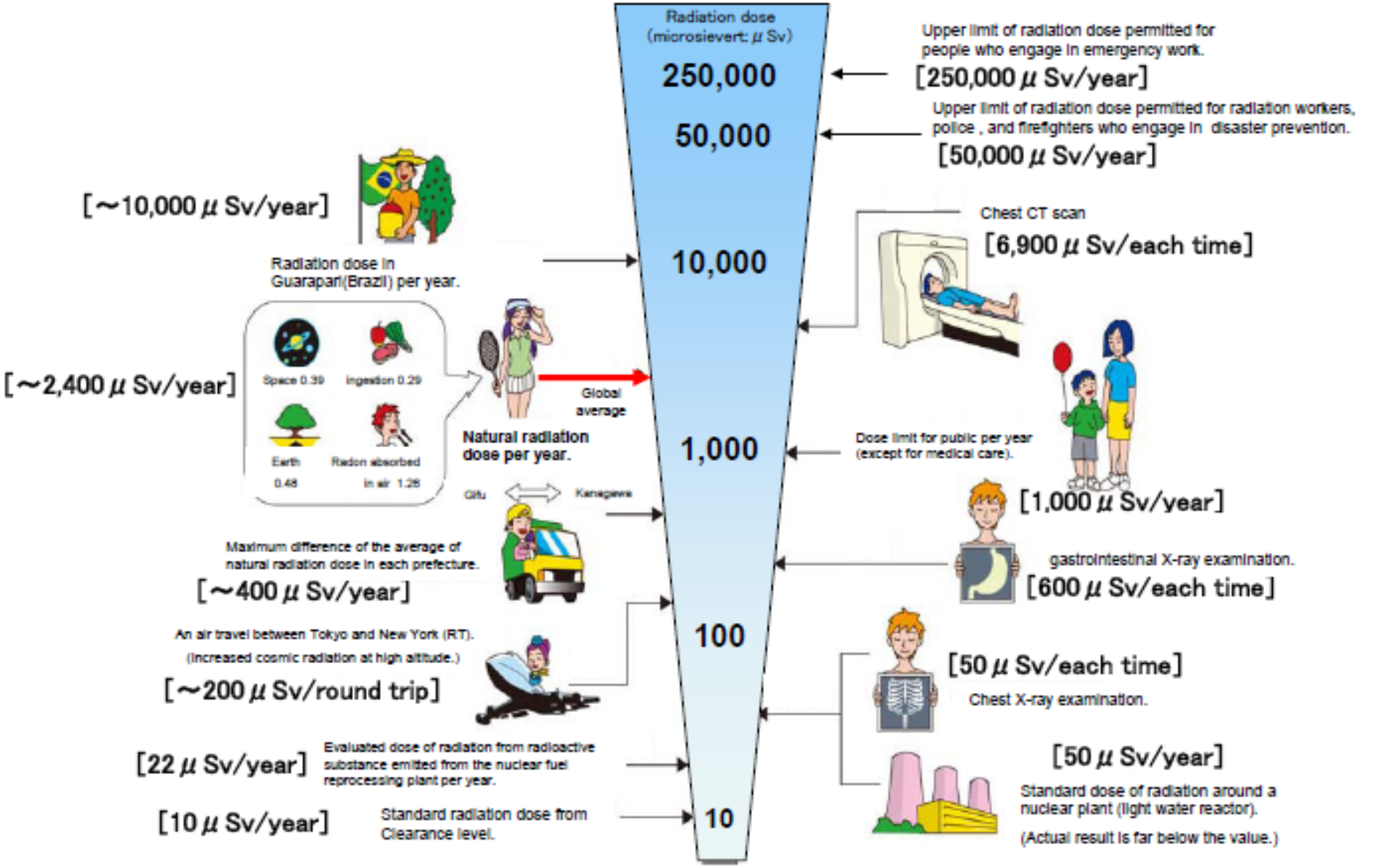
South water outlet
I-131: 1.8×10^2 Bq/cm^3 (X4385.0)
Cs-137: 47 Bq/cm^3 (X527.4)
as of 3/30 13:55

Main Gate
I-131: 4.1×10^{-4} Bq/cm^3 (0.41倍)
Cs-137: 4.0×10^{-5} Bq/cm3 (X0.01)
as of 3/30 2:00～2:20

:Sea area :Dust : Soil
I: Iodine, Cs: Cesium, Pu: Plutonium

Radiation in Daily-life

※Unit : μ Sv



Source: Ministry of Education, Culture, Sports, Science and Technology

Recovery status (Main Control Room)

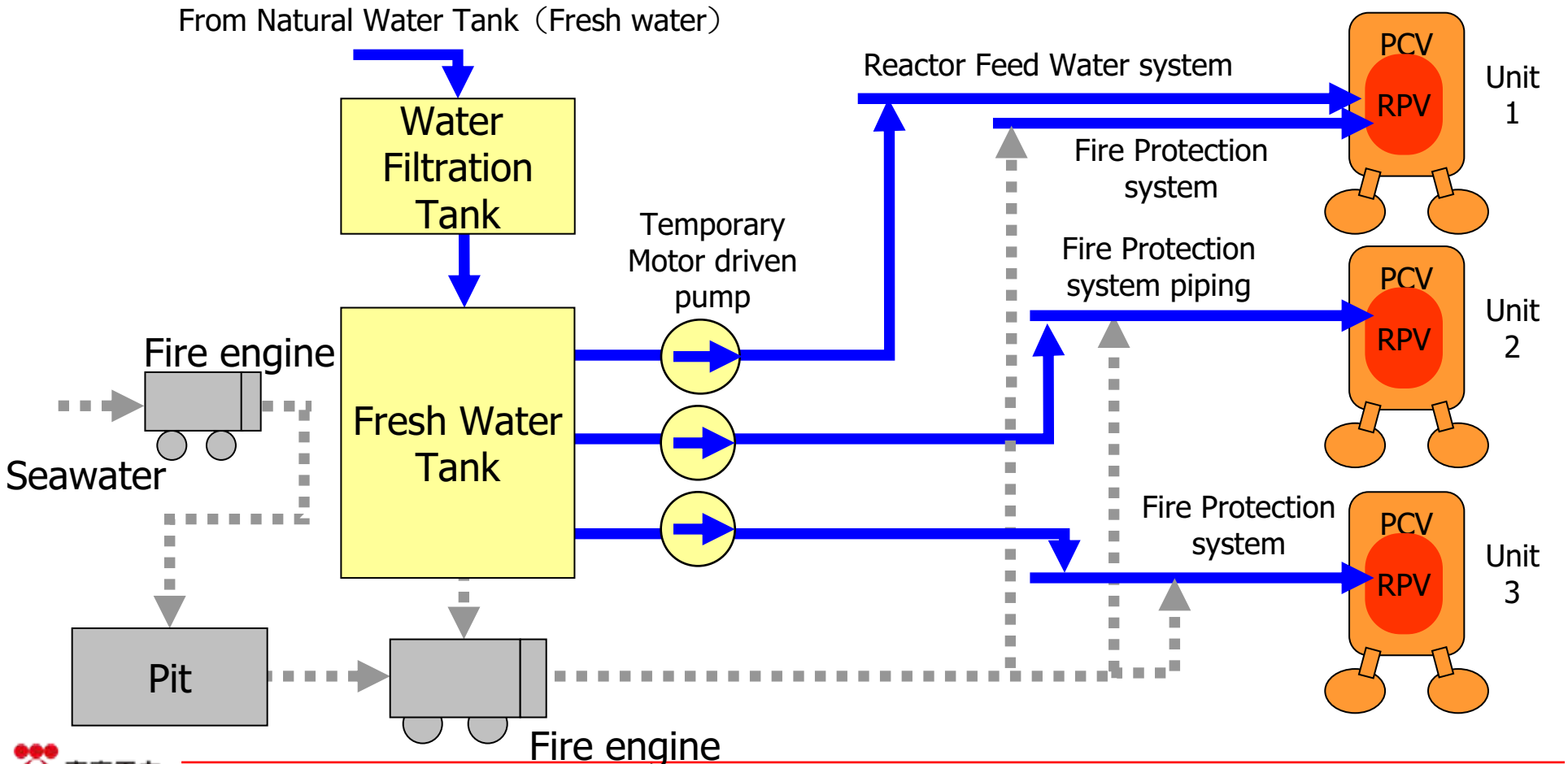
- Main Control Room Power recovered
  - March 22 22:45 Turn on Power to the Unit 3 Main Control Room
  - March 24 11:30 Turn on Power to the Unit 1 Main Control Room
  - March 26 16:46 Turn on Power to the Unit 2 Main Control Room
  - March 29 11:50 Turn on Power to the Unit 4 Main Control Room

Unit 1 Main Control Room turned on（The light fixture is broken by the earthquake）

Unit 1 Main Control Room Recovery

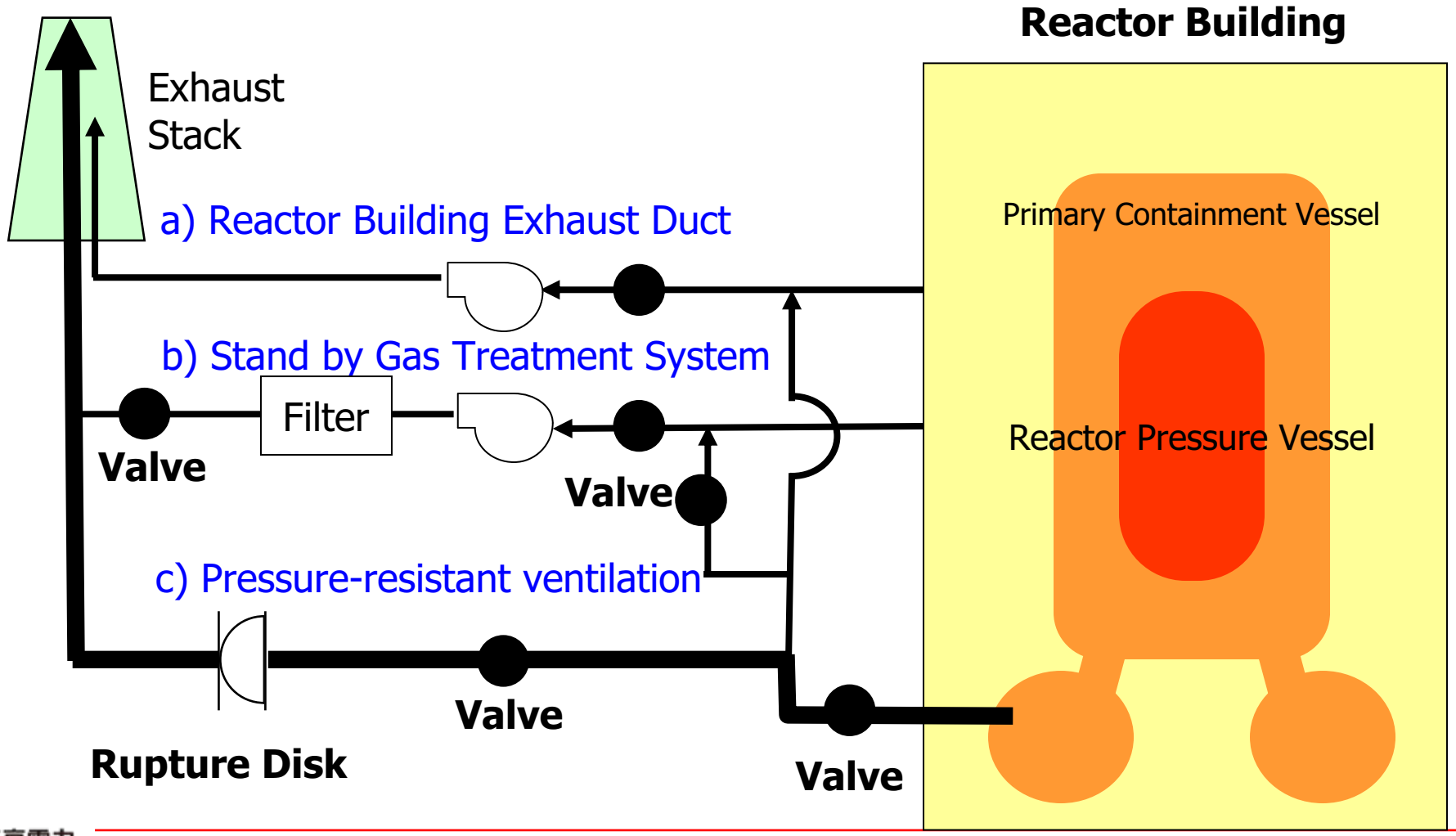
[Reference] Reactor Feed Water System

- Change over from seawater to fresh water with motor driven pump
  - Unit 1: 25 March, changed to fresh water, pump motorized on 29 March
  - Unit 2: 26 March, changed to fresh water, pump motorized on 27 March
  - Unit 3: 25 March, changed to fresh water, pump motorized on 28 March



[Reference] Measure to Decrease Pressure of PCV (Ventilation)

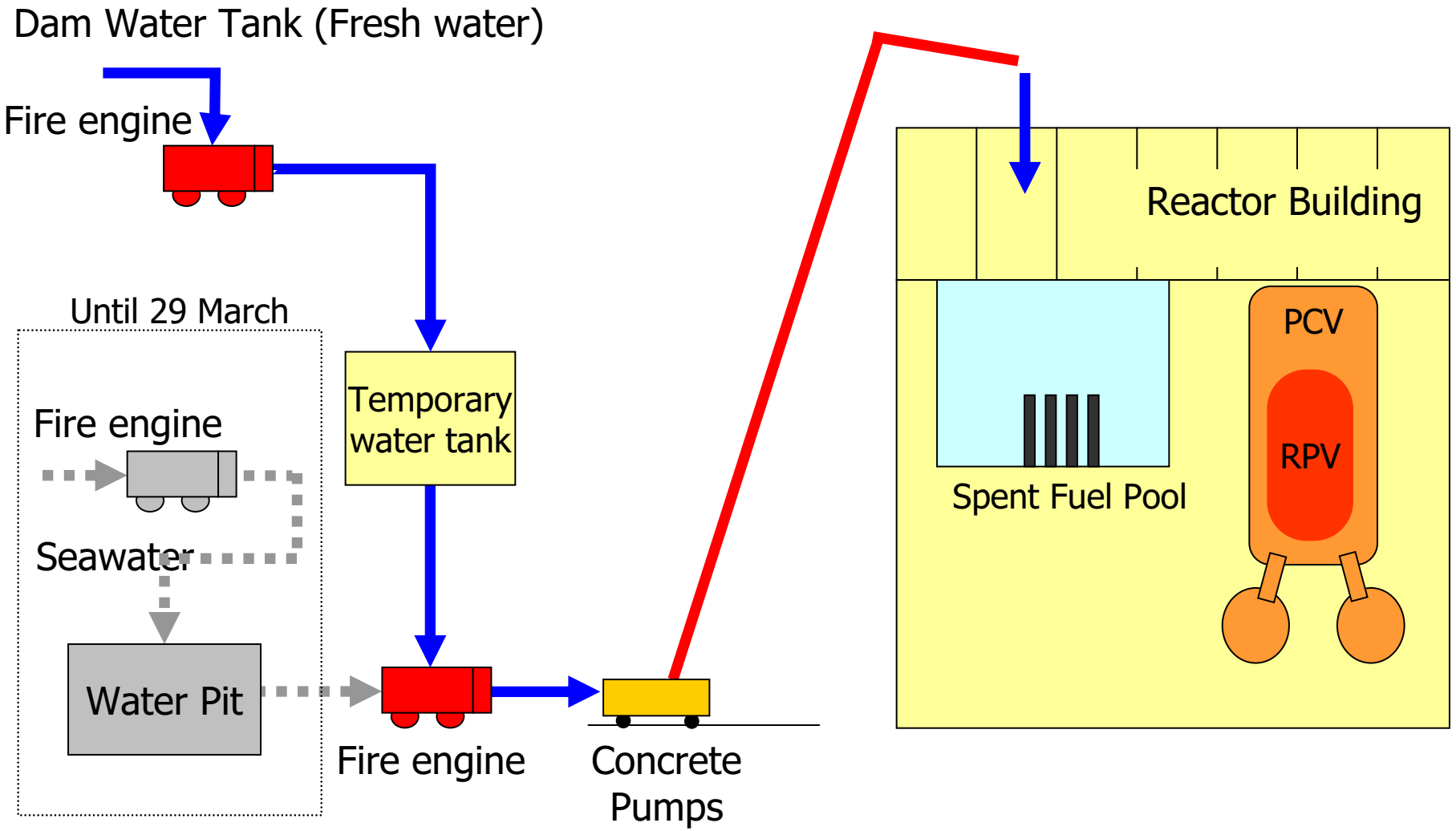
➢Ventilation by-passing filter was adopted in this accident



[Reference] Water spray into spent fuel pool

Unit 1,3 and 4: Water Spray with Fire Engines

Unit 2: Existing Fire Protection Line is used



[Reference] Water Removal Process from Turbine Building

- Investigating the source of the water
- Unit 2 surface rate is as high as 1000mSv/h
- Unit 1 pump up water to the condenser. The water will transferred to the Condenser Storage Tank and then to the Suppression Pool Surge Tank.
- Unit 2-4: Condenser Storage Tank water transferred to the Suppression Pool Surge Tank

<Water Paddle in Unit 2>