A One-year Review of Fukushima Daiichi Nuclear Power Station "Steps to Achieve Stabilization"

March 2012

TEPCO

Today’s Presentation

Fukushima Daiichi Nuclear Power Station reached a cold shutdown condition and Step 2 of Roadmap towards Restoration was completed in December 2011. Now the mid and long term approach for decommissioning is ongoing. We hereby would like to explain the approach from the accident towards the stabilization so far.

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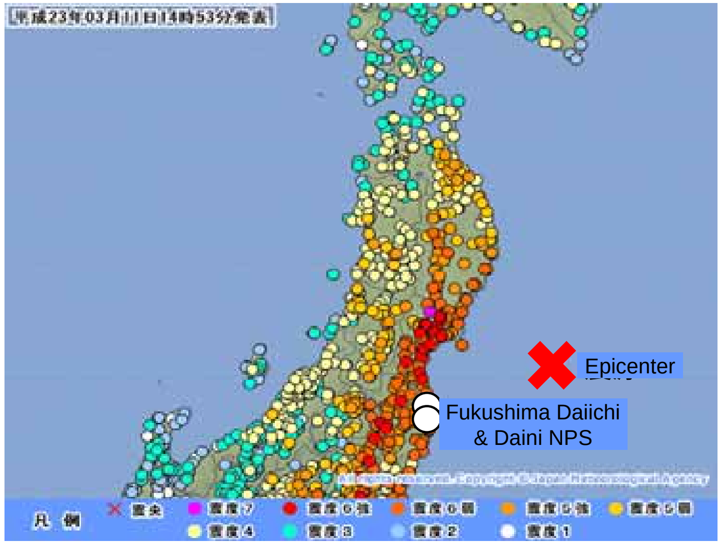
I. Accident Causes & Measures Taken

(1) Earthquake Impact

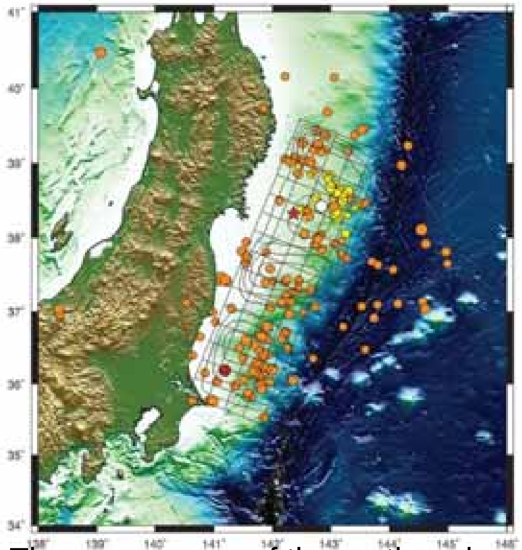
Scale of the Earthquake and Tsunamis

This was a massive M9.0 earthquake (fourth largest ever recorded in the world) that was caused by a coupling movement of several regions off-shore of Miyagi prefecture, the southern trench off-shore of Sanriku to the east, off-shore of Fukushima prefecture, and off-shore of Ibaraki prefecture.

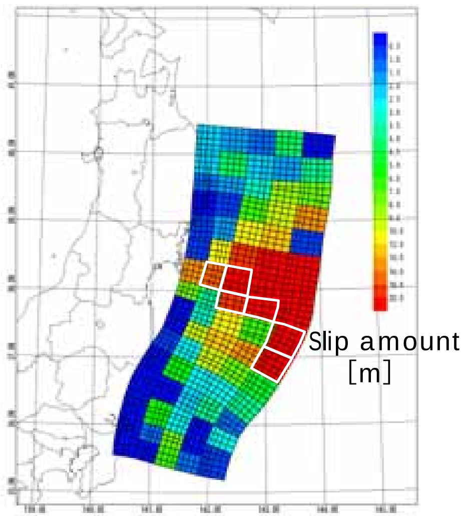
Time:	2:46 pm on Fri, March 11, 2011.
Place:	Offshore Sanriku coast (northern latitude of 38 degrees, east longitude of 142.9 degrees), 24km in depth, Magnitude 9.0
Intensity:	**Level 7** at Kurihara in Miyagi prefecture
	<u>Upper 6 at Naraha, Tomioka, Okuma, and Futaba in Fukushima pref.</u>
	Lower 6 at Ishinomaki and Onagawa in Miyagi pref., Tokai in Ibaraki pref.



Intensity Distribution of the earthquake



The source area of the earthquake
(Evaluated by Tokyo University)



Wave source of the tsunami on March 11
(Evaluated by TEPCO)

Intensity of the earthquake at the power stations

In Fukushima Daiichi the observed data partially exceeded the maximum response acceleration with respect to the design-basis earthquake, however most data was below the baseline

Observation Point (The lowest basement of reactor buildings)		Observed Data: Maximum Response Acceleration (gal)			Maximum Response Acceleration against Basic Earthquake Ground Motion (Gal)		
		Horizontal (N-S)	Horizontal (E-W)	Vertical	Horizontal (N-S)	Horizontal (E-W)	Vertical
Fukushima Daiichi	Unit 1	460*	447*	258*	487	489	412
	Unit 2	348*	**550***	302*	441	438	420
	Unit 3	322*	**507***	231*	449	441	429
	Unit 4	281*	319*	200*	447	445	422
	Unit 5	311*	**548***	256*	452	452	427
	Unit 6	298*	444*	244	445	448	415
Fukushima Daini	Unit 1	254	230*	305	434	434	512
	Unit 2	243	196*	232*	428	429	504
	Unit 3	277*	216*	208*	428	430	504
	Unit 4	210*	205*	288*	415	415	504

Status when the earthquake occurred : In operation (Fukushima Daiichi Units 1–3, Fukushima Daini Units 1–4), Shutdown (Fukushima Daiichi Units 4–6)

Note) Standard ground motion Ss: Seismic motion that was newly established to evaluate seismic safety, taking into account the earthquakes, etc., that could occur around the power station, based on the revised seismic design review guidelines.

The Earthquake Damage

Fukushima Daiichi

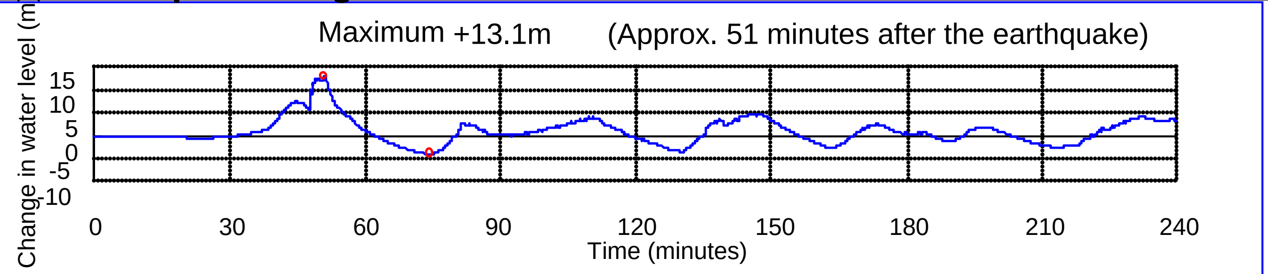
Fukushima Daini

Ground subsidence partially occurred

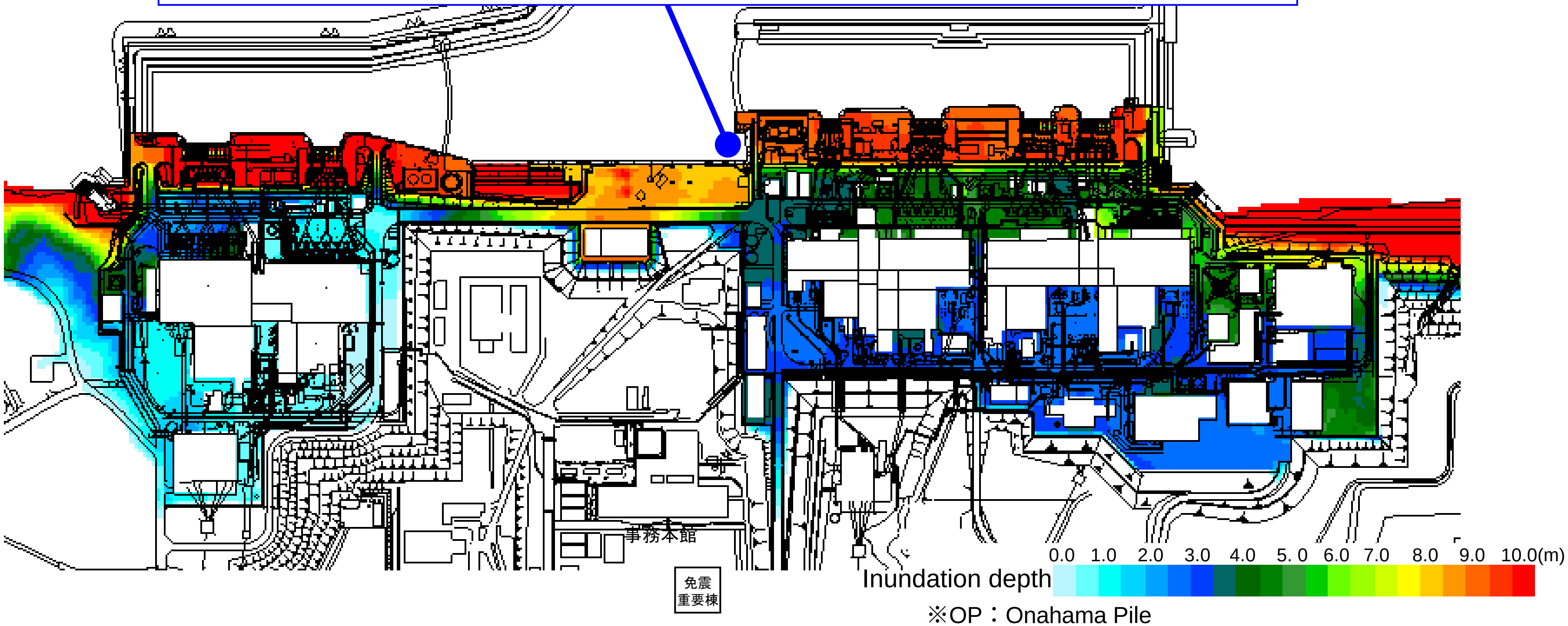
Tsunami height at Fukushima Daiichi

The tsunami height at Fukushima Daiichi Nuclear Power Station was far above the height (OP* + 5.4m ~ 6.1m) evaluated using the method of the Society of Civil Engineers.

The calculation results reproducing the tsunami that struck Fukushima Daiichi Nuclear Power Station



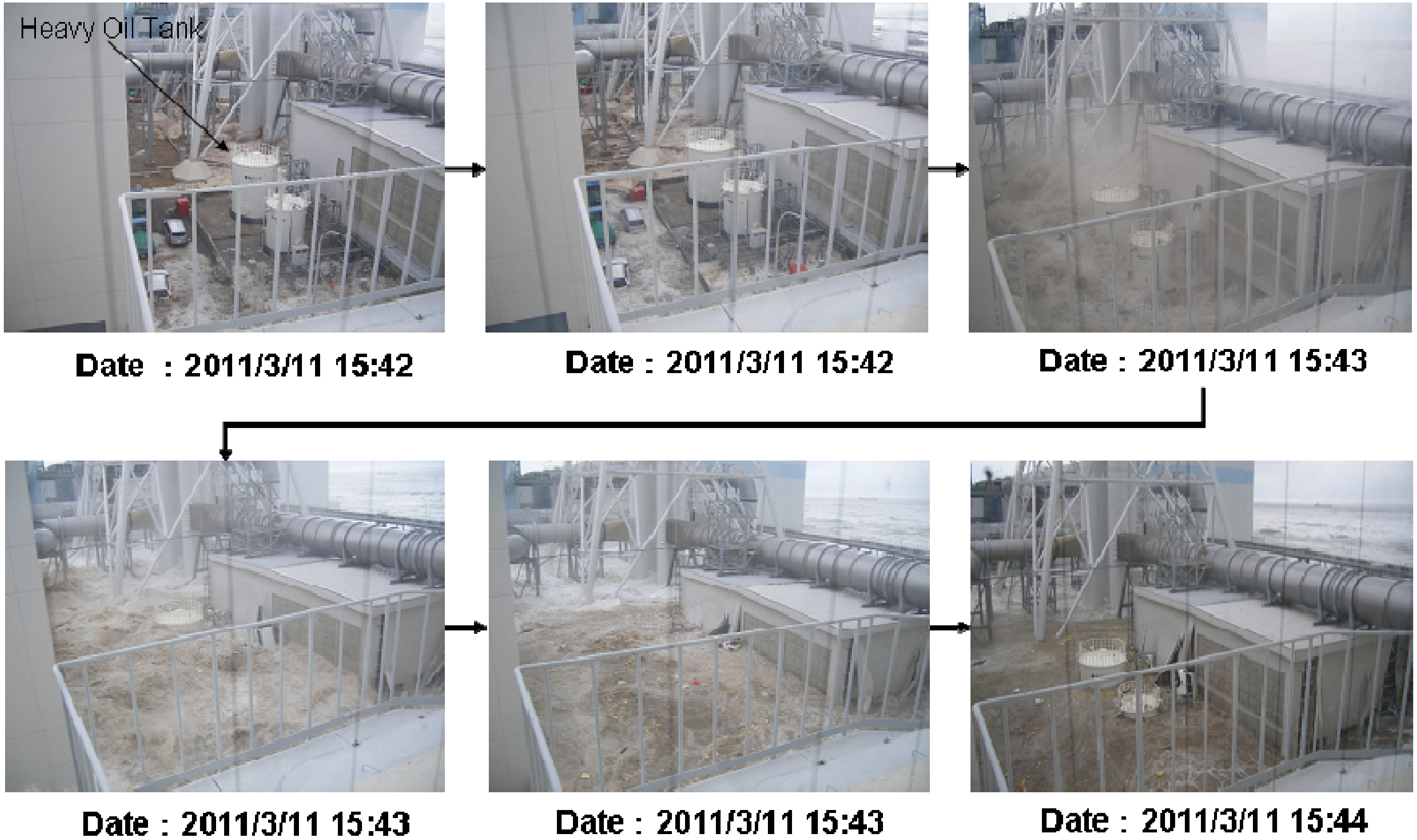
Reproduction calculation results of the tsunami that hit the Fukushima Daiichi Nuclear Power Station (changes in water level near the tide station)



※OP：Onahama Pile
（0.727m below the average sea level in Tokyo Bay）

Outdoor Tsunami Flooding（Fukushima Daiichi）

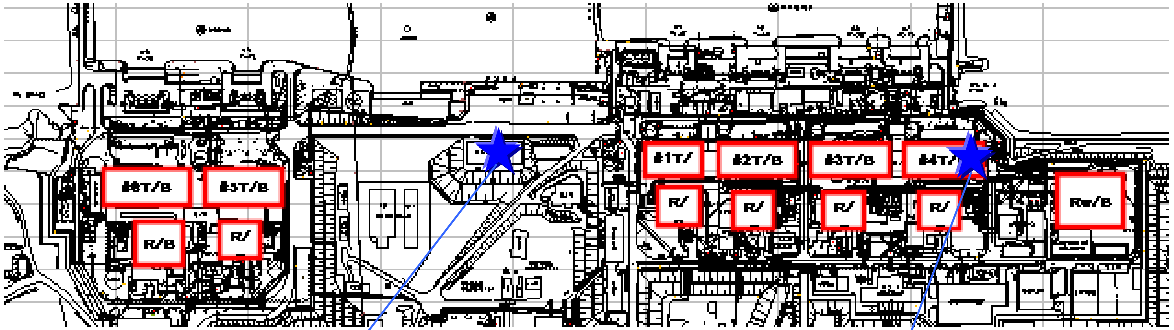
Heavy Oil Tank (about 5.5 m high) was submerged by the tsunami, which was located at the level of OP +10 m.



Outdoor flooding conditions at Fukushima Daiichi Nuclear Power Station

(Near the Unit 4 South-side Central Environmental Facility Process Main Building site height O.P.+10m, heavy oil tank height approximately 5.5m)

Tsunami Damage at Fukushima Daiichi



Rubble inside the building

The Tsunami Damage at Fukushima Daiichi

Before March 11th

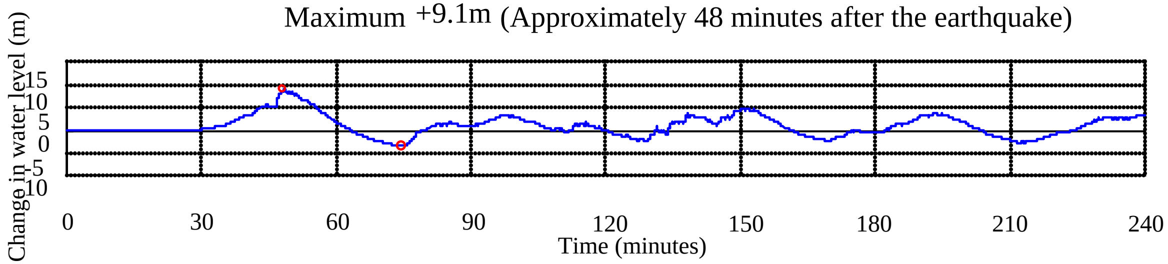
Washed Away Trees

After March 11th

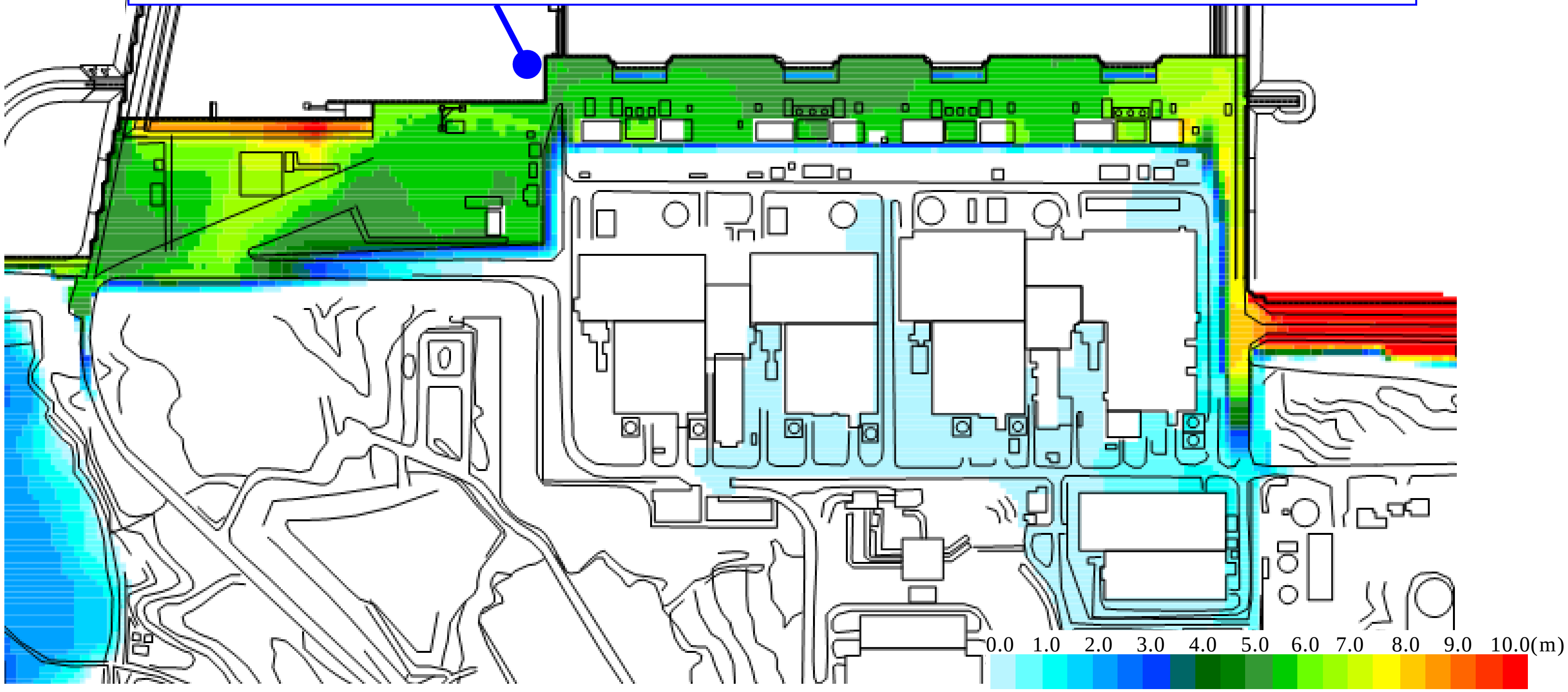
Tsunami height at Fukushima Daini

The calculation results reproducing the tsunami that struck Fukushima Daini Nuclear Power Station (inundation depth and inundated area)

Maximum +9.1m (Approximately 48 minutes after the earthquake)



Reproduction calculation results of the tsunami that hit the Fukushima Daini Nuclear Power Station (changes in water level near the tide station)



The Tsunami Damage at Fukushima Daini

(1) Tsunami overflow

Outside of Unit 1 emergency air blower room

Inundation through the louver of Unit 1 Reactor Annex Building

Unit 1 emergency diesel control room (A)

(2) Damage to the low area (Pickup area)

(3) No damage to Turbine Building of Units 3 and 4

Inside of Unit 1 emergency air blow room

Response of Fukushima Daiichi Units 1 to 3 (from Earthquake to Tsunami)

Although external power was lost due to the earthquake, the “Shutdown”, “Cool” and “Containment” operations along with the plant responses were properly implemented prior to the arrival of the tsunami.

Status of Fukushima Daiichi Units 1 to 3
Response between Earthquake and Tsunami (“Shutting down”& “Cooling down”)

Event	Expected plant response	Unit 1	Unit 2	Unit 3	Units 1/2 Main Control Room	Units 3/4 Main Control Room	Main Administration Building
Earthquake occurrence <Shutting down>	-Scram -Insertion of all control rods -Reactor sub criticality check	○ ○ ○	○ ○ ○	○ ○ ○	-The operators waited for the shaking to subside then started normal scram operations -An operator was assigned to each control panel, and condition-monitoring and operations were conducted in accordance with instructions from the supervisor	-While the Main Control Room became clouded with dust, like a smoke curtain, the operators waited for the shaking to subside and then started normal scram operations	-Evacuation and confirmation of safety -Emergency disaster response personnel started responding at the anti-seismic building
External power loss <Cooling>	-Emergency diesel generator (D/G) startup -Main steam isolation valve (MSIV) all closed -Isolation condenser (IC) startup -Reactor core isolation cooling system (RCIC) startup -High pressure coolant injection system (HPCI) startup (if the water level decreases to L2)	○ ○ ○ — —* *No startup, as there were no major decreases in water level	○ ○ — ○ —*	○ ○ — ○ —*	<Unit 1 > -Checked that the IC automatically started up -As the reactor water level was normal, IC was used to control reactor pressure rather than the HPCI -Determined that one IC system was sufficient, and the reactor pressure was controlled using the A system. <Unit 2 > -RCIC was manually started up (manual startup was implemented again later)	<Unit 3 > -Checked that the D/G started up and the emergency bus was charged -RCIC was manually started up and confirmed that it was tripped due to reactor water level high ↓ -After the earthquake, the safety of the operators was confirmed, and information regarding the earthquake and tsunami was disseminated by paging	

Immediate Post Earthquake Plant Conditions (Unit1 (1))

The scram was activated at 14:46 on March 11th, and all control rods were inserted at 14:47. Afterwards the reactor pressure was controlled within the approximate range of 6 ~ 7 MPa and there are no signs of any piping ruptures.

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  H  MIN  SEC MSEC     PID   ABBREVIATION              STATUS
 14   46   46  400   D564*  SEISMIC   TRIP C           TRIP
 14   46   46  410   D534   REACTOR   SCRM A           TRIP
 14   46   58  420   D563   SEISMIC   TRIP B           TRIP
 14   46   58  430   D535   REACTOR   SCRM B           TRIP
1446  A538 RBM       BYPS          ON
1446  B500 CONT ROD DRFT ALRM      ON
 14   47   00  020   D562   SEISMIC   TRIP A           TRIP
 14   47   00  030   D565   SEISMIC   TRIP D           TRIP
1447  C020 SUPPRESSION   LEVL   -40.8< -20.0 MM
1447  A523 APRM      DOWN SCAL    TRBL
1447  A539 RWM       ROD  BLOK     ON
1447  A553 ALL CR FULL IN          ON
1447  G002 GENERATR VOLT         18.56> 18.50 KV
1447  C000 CONT ROD SYST FLOW   OVR FLW
1447  C020 SUPPRESSION   LEVL     16.0 MM   NORMAL RETURN
 14   47   09  140   D520   REAC WTR LEVL A            LOW
1447  C004 REACTOR  WATR LEVL      516<   800 MM
 14   47   09  150   D521   REAC WTR LEVL B            LOW
1447  E004 SWCHGEAR BUS  1A       7217>  7200 V
 14   47   10  910   D523   REAC WTR LEVL D            LOW
1447  C020 SUPPRESSION   LEVL      21.6>  20.0 MM
 14   47   10  910   D522   REAC WTR LEVL C            LOW
1447  A549 LOW POWR ALRM POINT   UNDER
 14   47   20  620   D522   REAC WTR LEVL C            NORM
1447  D622 PCIS ISO IN  TRIP       ON
 14   47   20  620   D523   REAC WTR LEVL D            NORM
```

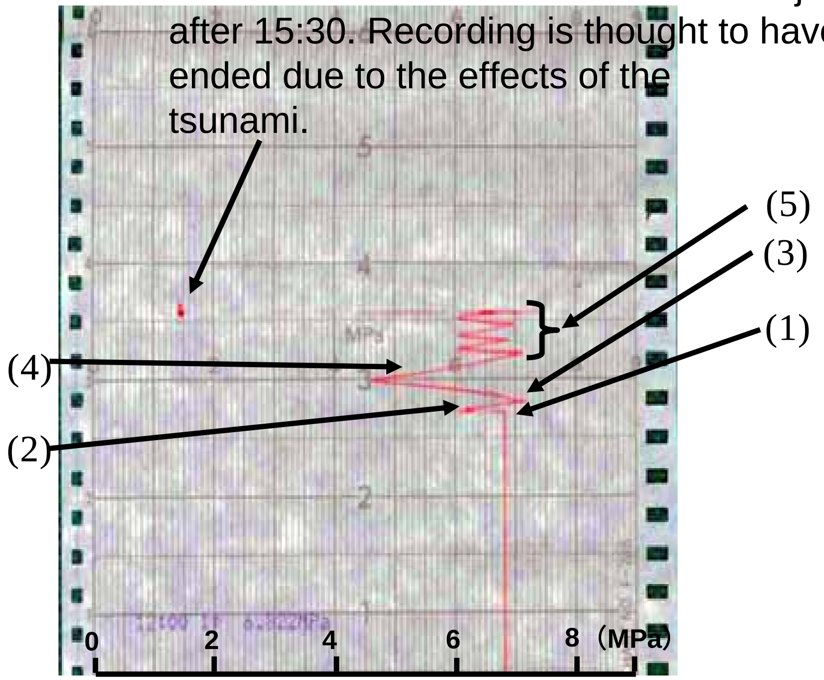
(1)

(2)

(1) Automatic scram due to the earthquake
(2) Total insertion of all control rods

Alarm Recorder in Unit 1 (SCRAM)

*It is assumed that the tsunami struck just after 15:30. Recording is thought to have ended due to the effects of the tsunami.



(1) Scram due to the earthquake (14:46)

※IC: Isolation Condenser

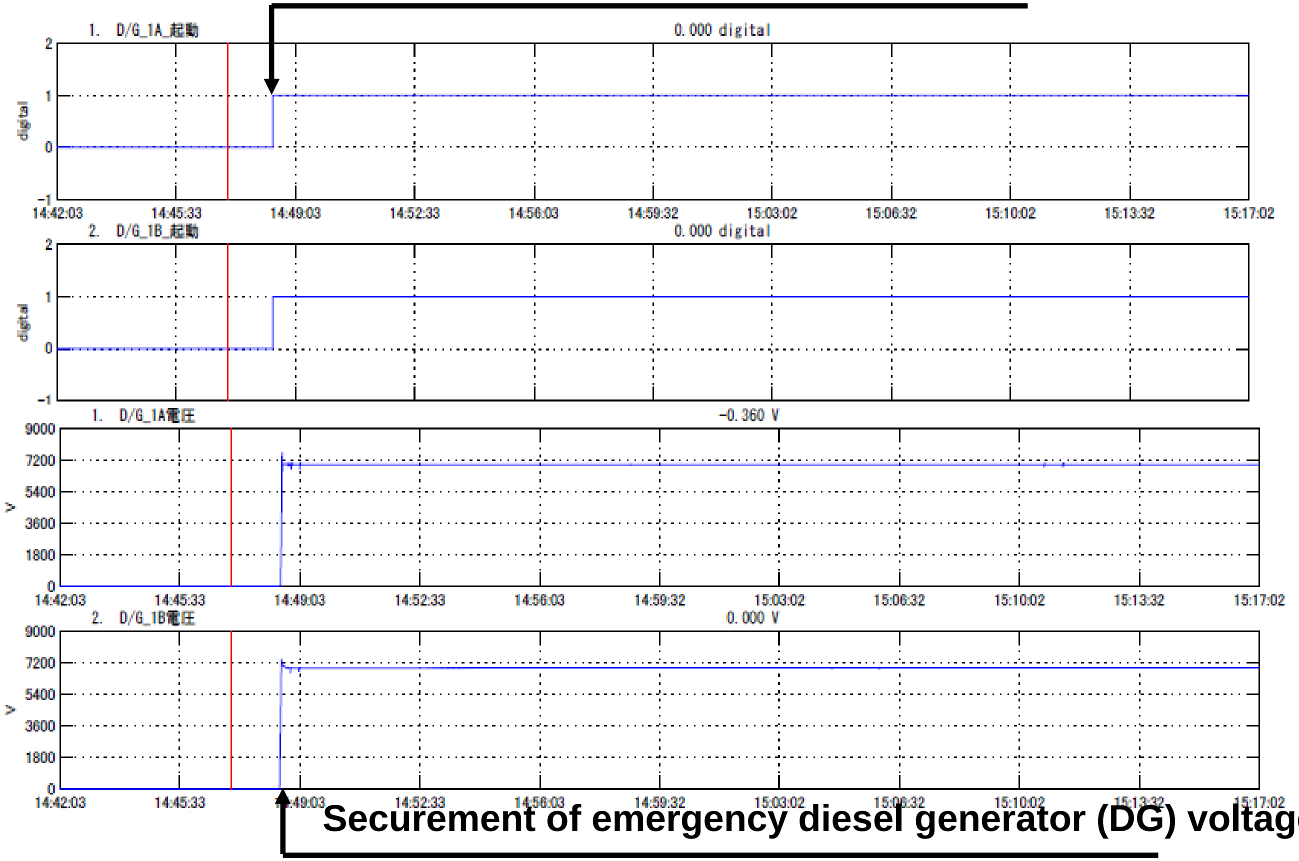
(2) Increase in pressure following closure of the main steam isolation valve
(3) Decrease in pressure following IC operation (14:52)
(4) Increase in pressure following IC shutdown
(5) Pressure fluctuation (estimated) due to the IC

Strip Chart in Unit 1 (Reactor Pressure)

Immediate Post Earthquake Plant Conditions (Unit1 (2))

Following the loss of site power due to the earthquake, all of the emergency diesel generators (D/G) in each unit kicked in as they were designed to, allowing us to secure a power source.

Emergency Diesel Generator (D/G) Automatically Start Up



Securement of emergency diesel generator (DG) voltage

<u>Transient Recorder in Unit 1 (Emergency Diesel Generator)</u>

Plant Evaluation of the Earthquake's Impact (1)

It is estimated that the safety functions of the important safety-related equipment had been secured after the earthquake because the stress strain analysis with actual seismic records resulted below the design basis in all equipments.

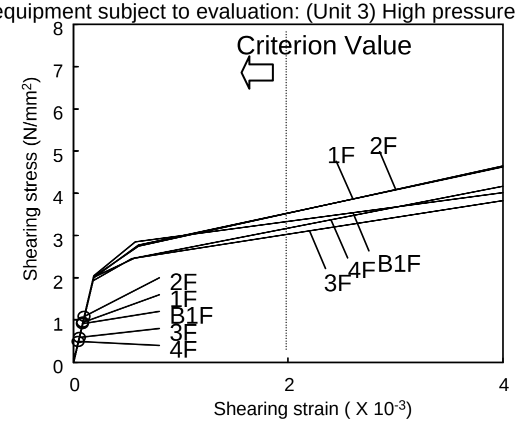
Results of the seismic assessments of Units 1-3
(there is no problem if the calculated value is smaller than the standard evaluation value)

Unit：MPa (No unit for Reactor Building)

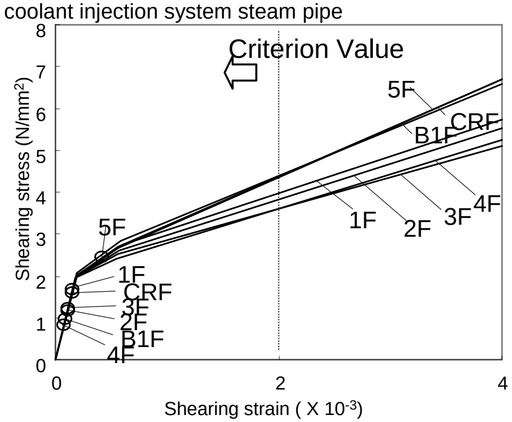
Structure & Component		Unit 1		Unit 2		Unit 3	
		Calculated Value	Criterion Value	Calculated Value	Criterion Value	Calculated value	Criterion Value
Reactor Building		0.14 X 10^{-3}	2 X 10^{-3}	0.43 X 10^{-3}	2 X 10^{-3}	0.14 X 10^{-3}	2 X 10^{-3}
Reactor core support structure		103	196	122	300	100	300
Reactor pressure vessel		93	222	29	222	50	222
Main steam system piping		269	374	208	360	151	378
Reactor containment vessel		98	411	87	278	158	278
Shutdown cooling system	Pump	8	127				
	Piping	228	414				
RHR	Pump			45	185	42	185
	Piping			87	315	269	363
Others*		—	—	—	—	113	335

* Other listed equipment subject to evaluation: (Unit 3) High pressure coolant injection system steam pipe

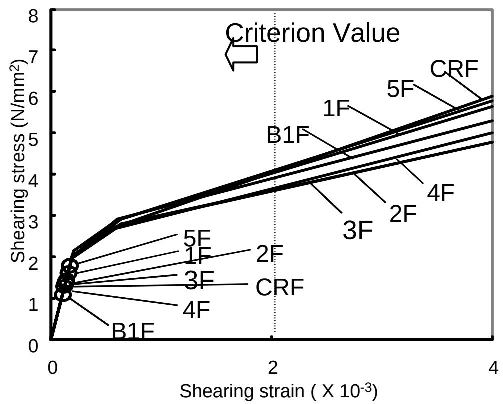
**It is estimated that the safety functions had been secured in Units 4 to 6 of Fukushima Daiichi and all Units of Fukushima Daini as well according to the same analysis.



Unit 1 (East-West direction)



Unit 2 (East-West direction)



Unit 3 (East-West direction)

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Plant Evaluation of the Earthquake's Impact (2)

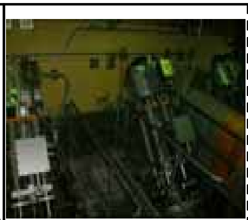
No damage confirmed

Visual check results of Fukushima Daiichi Unit 5

No damage confirmed to important safety-related equipments

Reactor Building

4th floor
3rd floor
2nd floor
1stfloor



Main steam isolation valve
・No equipment abnormality in terms of external appearance

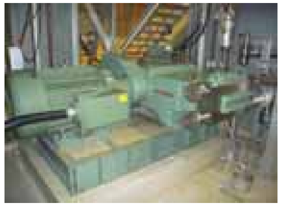
1st floor

Reactor Auxiliary Cooling Water System Heat exchanger
・ No equipment abnormality in terms of external appearance

2nd floor

Fuel Pool Cooling system pump
・Although some signs of corrosion (rust development) is found in both units, there are no equipment abnormalities in terms of external appearance (A) In operation, (B) On standby

3rd floor



Standby liquid control system pump
・No equipment abnormality in terms of external appearance

4th floor

Basement

Core spray system pump
・No equipment abnormality in terms of external appearance
・Retained water on the floor
・ Signs of leakage on the wall penetration in the same area

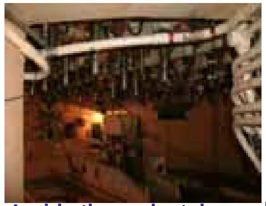
Residual Heat Removal System pump
・No equipment abnormality in terms of external appearance
・Retained water on the floor

Control rod drive water pump
・No equipment abnormality in terms of external appearance

Inside the containment vessel

Main steam isolation valve
・No equipment abnormality in terms of external appearance

Safety relief valve
・No equipment abnormality in terms of external appearance



Inside the pedestal
・No equipment abnormality in terms of external appearance

Reactor pressure vessel support skirt
・Although there is rust on the foundation bolt, there are no equipment abnormalities in terms of external appearance

Turbine Building

2 nd floor

High-pressure turbine
・There are some cracks on the front standard foundation bolt

1 st floor

Moisture separator
Insulation and support came loose

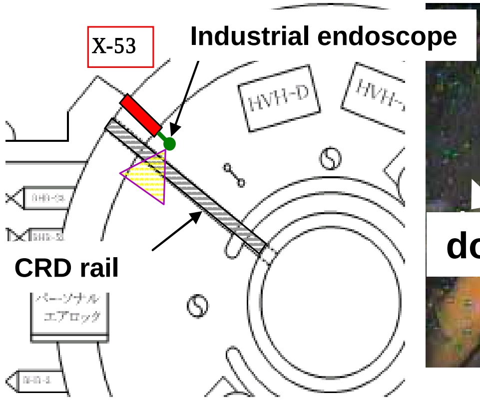
Pipe around the moisture separator
No3 Damage to the small diameter pipe that branches off from the moisture separator drain pipe

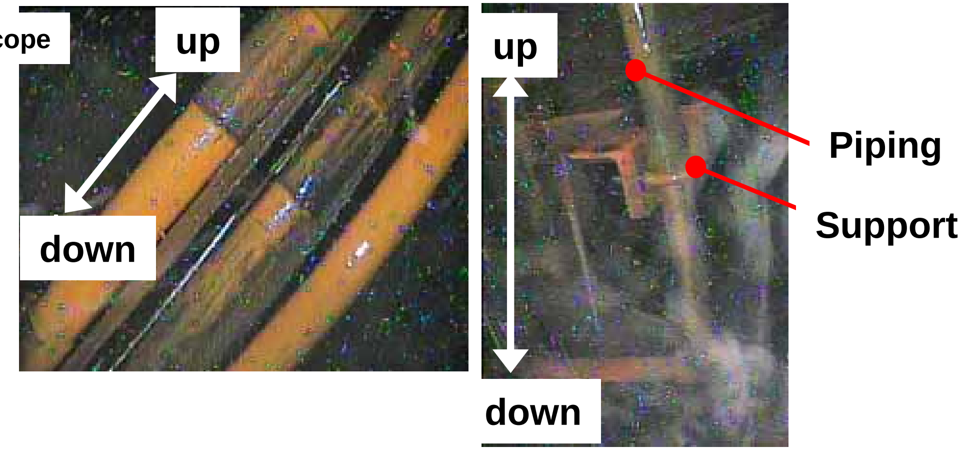
Basement

Emergency diesel generator 5A,5B
・No equipment abnormality in terms of external appearance

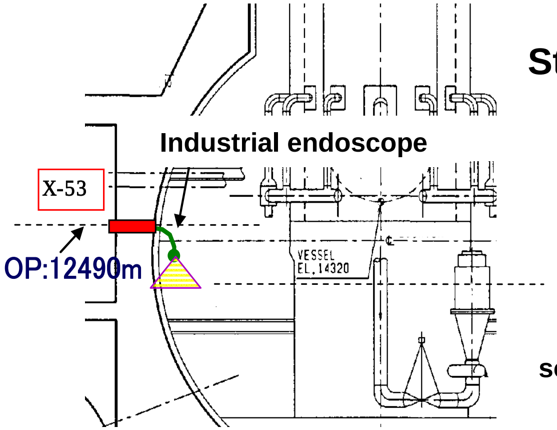
Plant Evaluation of the Earthquake's Impact (3)

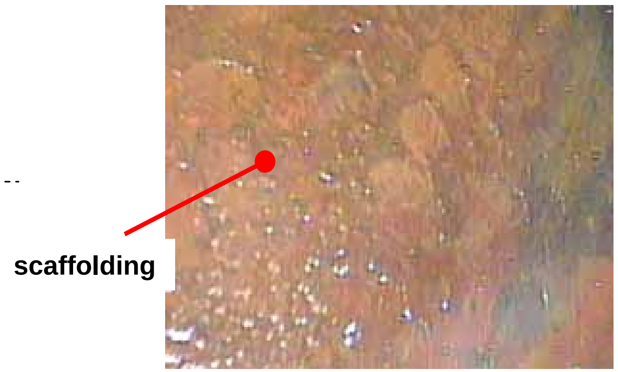
No damage was confirmed to the small-diameter piping inside the PCV according to the video observation in Unit 2 of Fukushima Daiichi





Structure of small-diameter piping or electric conduit





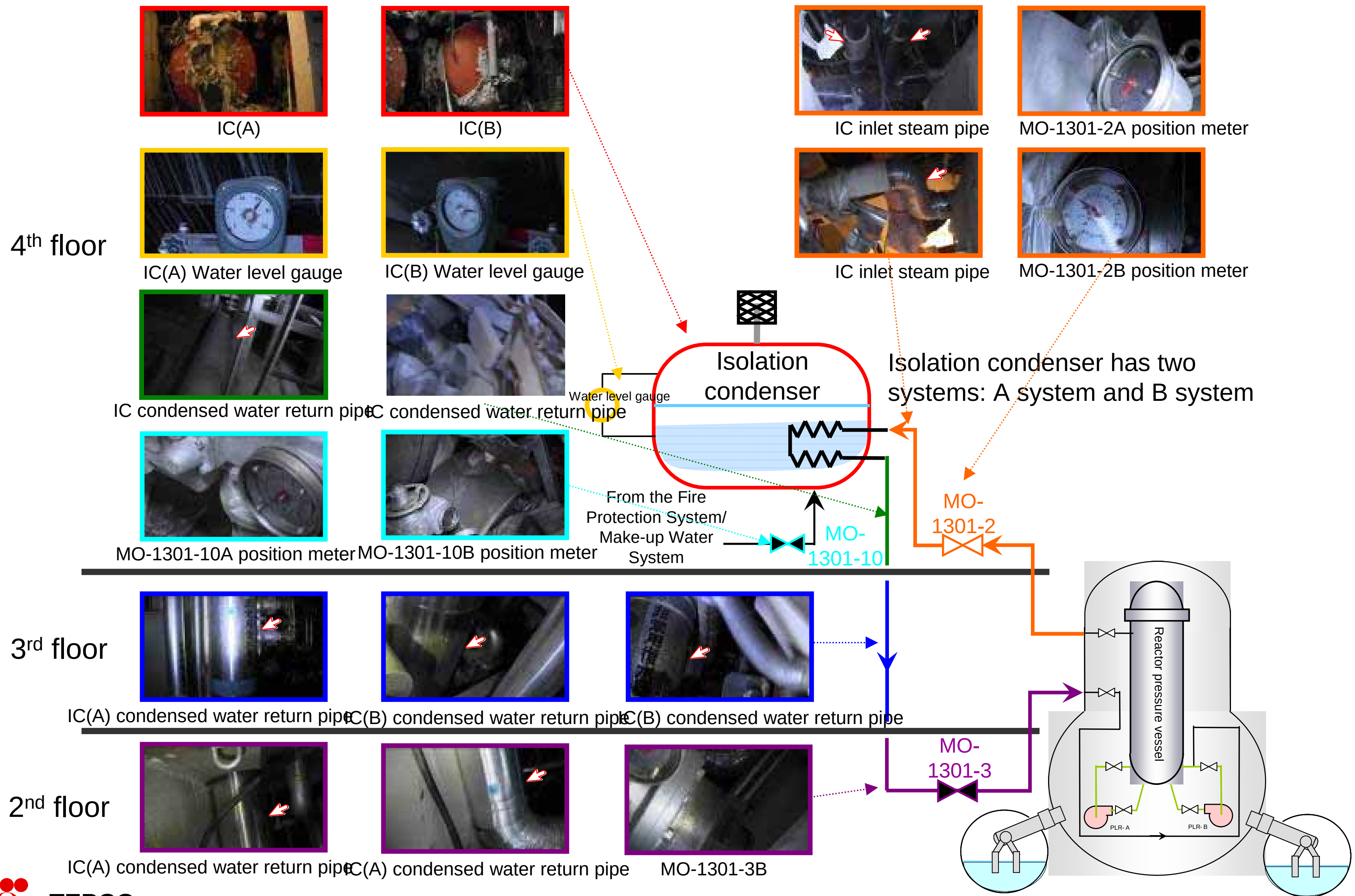
PCV inside wall

(2012.1.19)

: **Observation direction**

Plant Evaluation of the Earthquake's Impact (4), Unit 1 IC

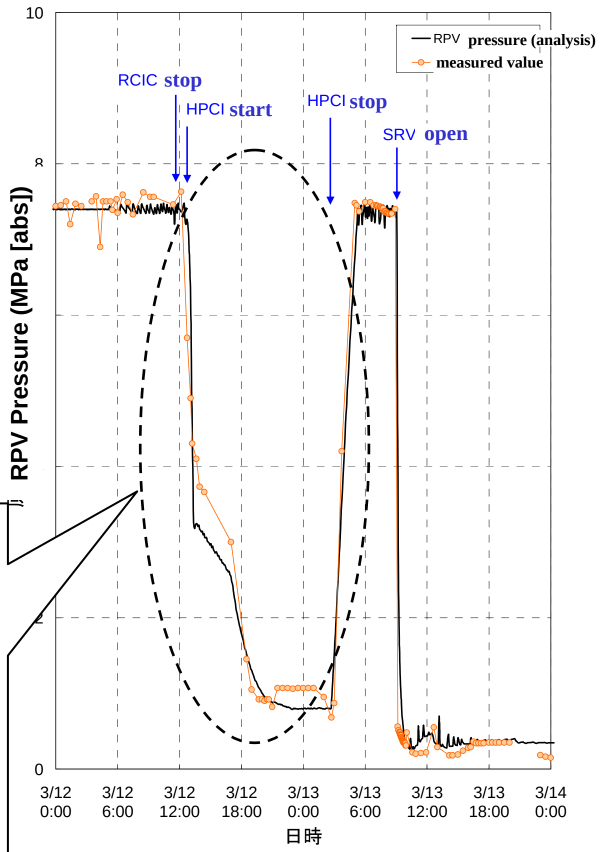
No damage was confirmed to the body and piping of Unit 1 IC as a result of visual observation where possible.



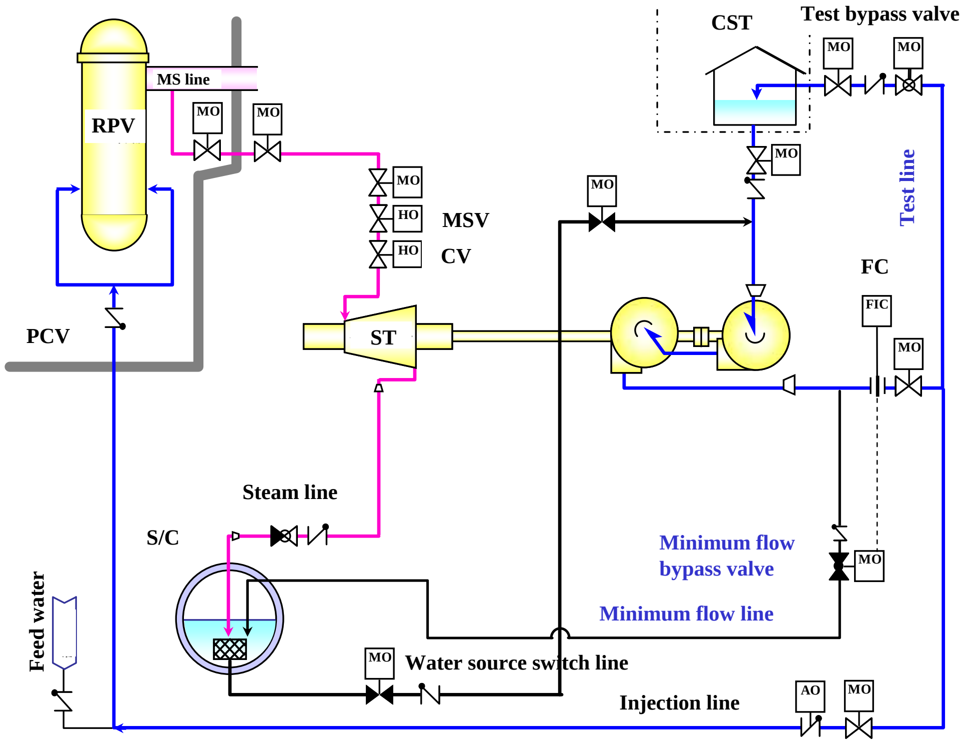
Note) The valve position display is for the standby status

Plant Evaluation of the Earthquake's Impact (5), Unit 4 HPCI

Although the piping rupture of HPCI in Unit 3 was a concern considering the reactor pressure decrease, no damage was confirmed by the operator who investigated in the field after HPCI had been brought to a stop. The reactor pressure decrease during HPCI operation is due to its continuous water injection.



- The reactor pressure decreased after HPCI start-up and maintained near 1MPa.
- After HPCI stopped, the reactor pressure increased.
- The decreased reactor pressure is simulated with operator's flow control by analysis.



HPCI system diagram
(Emergency cooling water injection system to the reactor)

Summary (Impact of the earthquake)

- **Although the external power at Fukushima Daiichi was lost due to the earthquake, it is estimated that the power supply was secured by emergency diesel generators and the plant was in a condition to be properly managed after the earthquake.**

(1) “Shutdown”, “Cool” and “Containment” operations along with plant response and parameters were properly implemented.

(2) Estimated that the safety functions of important safety-related equipment were secured according to an analysis of observed seismic records.

(3) No damage to the important safety equipment was confirmed after Unit 5 investigation etc.（Damage was hardly observed even in the functions of the low seismic-level equipment.）

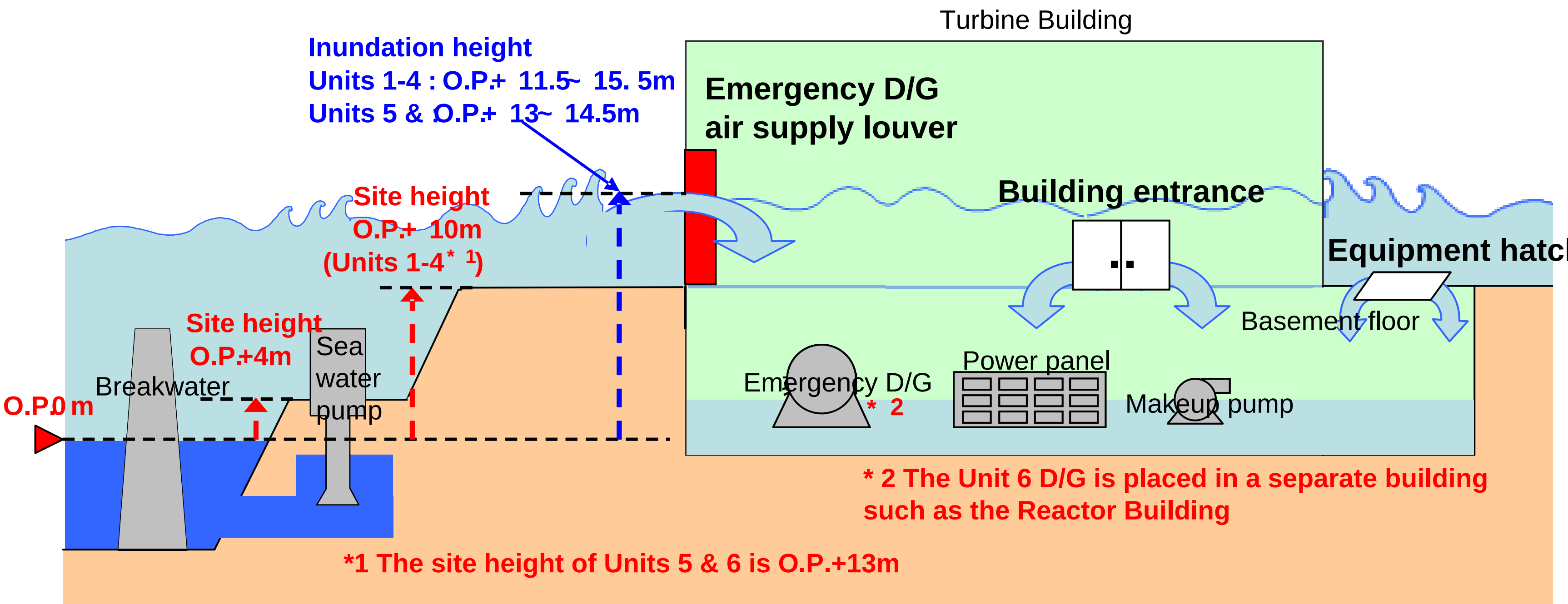
I. Accident Causes & Measures Taken

(2) Following the tsunami strike

Flooding Path into the Main Building

Emergency diesel generators and electrical equipment rooms were flooded through (1) entrance of the building, (2) equipment hatch, (3) inlet air louver of emergency D/G, (4) trench and duct (cable penetrations etc.), and lost its functions.
Emergency sea water pumps outdoor were submerged and lost its function.

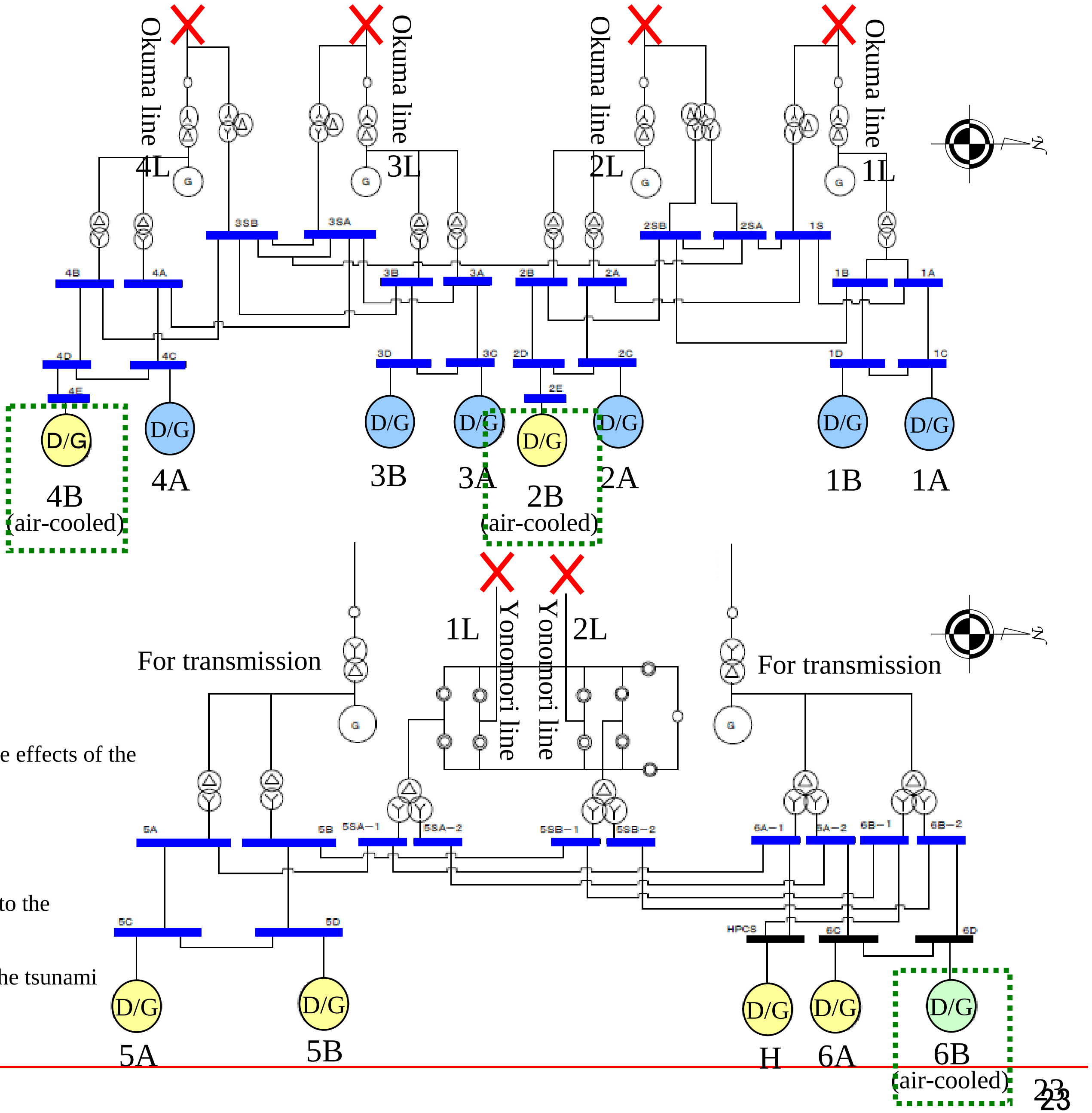
D/G：Diesel Generator
OP：Onahama Pile
（0.727m below the average sea level in Tokyo Bay）



Damage to Fukushima Daiichi (Power supply)

Damage to emergency diesel generators（D/G）

- All emergency D/Gs in Units 1 to 5 were stopped and resulted in AC power loss.
- One air-cooling emergency D/G in Unit 6 could continue its operations and the power supply was maintained.



: Shut down due to effects of the earthquake

: Power panel was damaged or submerged due to the effects of the tsunami

D/G : Still operable after the tsunami

D/G : M/C and related equipment were submerged due to the effects of the tsunami

D/G : Main unit was submerged due to the effects of the tsunami

Damage to Fukushima Daiichi and Daini（Power supply）

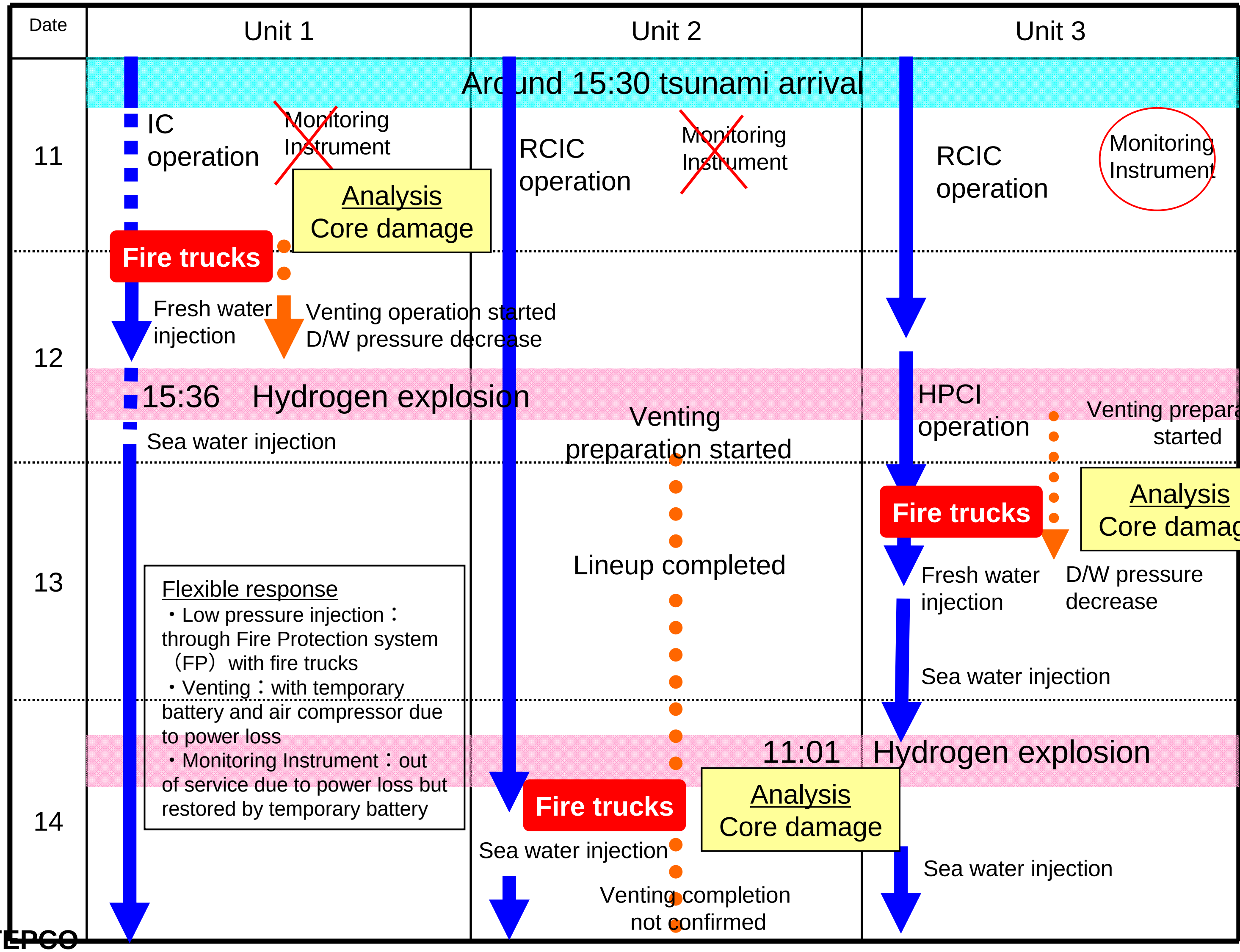
A serious situation occurred at Units 1 to 4 of Fukushima Daiichi when the external power, the function of emergency diesel generators with M/C and P/C, and DC power supply along with the heat removal function of sea water pumps were lost.

		Fukushima Daiichi						Fukushima Daini			
		1F-1	1F-2	1F-3	1F-4	1F-5	1F-6	2F-1	2F-2	2F-3	2F-4
External power supply		×				×		○			
Emergency diesel generator（*: Air-cooling）	A	×	×	×	×	△	△	×	△	△	△
	B	×	△*	×	△*	△	○*	×	△	○	△
	H	—	—	—	—	—	△	×	△	○	○
Emergency M/C		×	×	×	×	×	○	1/3	○	○	○
Normal M/C		×	×	×	×	×	×	○	○	○	○
Emergency P/C ( ) : number of systems under maintenance		×	2/3	×	1/2 (1)	×	○	1/4	2/4	3/4	2/4
Normal P/C ( ) : number of systems under maintenance		×	2/4	×	1/1 (1)	2/7	×	○	○	○	○
DC power supply		×	×	○ → ×	×	○	○	3/4	○	○	○
Sea water pump		×	×	×	×	×	×	×	×	1/2	×

○ : Available（or number of available systems）
△ : Not available due to submerged M/C etc. although D/G not flooded
× : Not available　　— : No system

Response after tsunami arrival (Fukushima Daiichi Units 1 to 3)

During loss of cooling water injection functions due to AC and DC power loss, alternative water injection into the reactors was conducted using fire trucks and PCV venting was conducted by improvised manual operations using temporary equipment.



IC：Isolation condenser
RCIC：Reactor Core Isolation Cooling
HPCI：High Pressure Core Injection
D/W：Dry Well（Air side）

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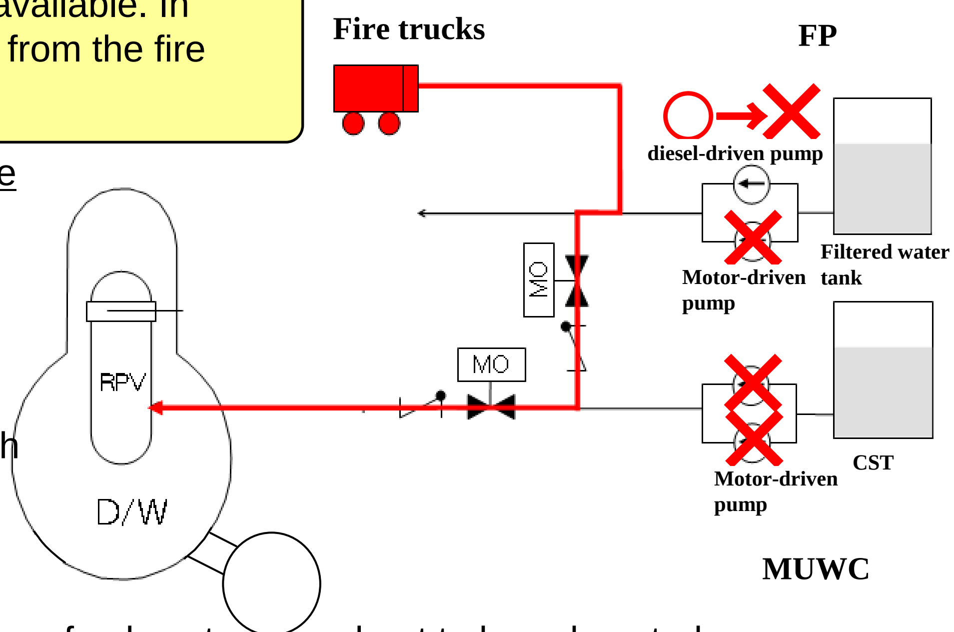
Response to Fukushima Daiichi Unit 1（Water injection to Reactor）

Improvised water injection was conducted with fire trucks prepared as a countermeasure after the Chuetsu-oki earthquake because the power supply was lost and diesel-driven fire pumps were not available. In addition, the water source had to be promptly switched from the fire protection water tank (fresh water) to sea water.



Water injection was prepared with one fire truck available

- Debris and scattered gates or cars on the roads were removed by two heavy equipment to gain access to the water injection inlet.
- It took time to find the water injection inlet after the debris had been removed.
- As the radiation dose had been increased after fresh water injection started, the operation was once suspended and restarted after the full-face masks were prepared.

The site superintendent instructed sea water injection when fresh water was about to be exhausted

- For sea water injection, three fire trucks including two provided by Kashiwazaki-Kariwa NPP and Self-Defense Forces were lined up in series utilizing the Unit 3 backwashing valve pit as a water source.
- Hoses for sea water injection became unavailable after the reactor building exploded before completion of the installation of the hoses..
- Sea water injection was started after injured staff were rescued and hoses were collected from the outdoor fire hydrant and then lined up again.*

*: Approval from the Prime Minister (the director-general of emergency response headquarters) was not confirmed for sea water injection and TEPCO headquarters instructed the site superintendent to stop temporarily. As it was deemed necessary, the site superintendent continued sea water injection.

Response to Fukushima Daiichi Unit 1 (PCV venting)

Normally venting can be operated from the main control room, but due to the power loss, actions outside of the normal procedures had to be taken.

Manual opening of PCV venting valve (MO valve)

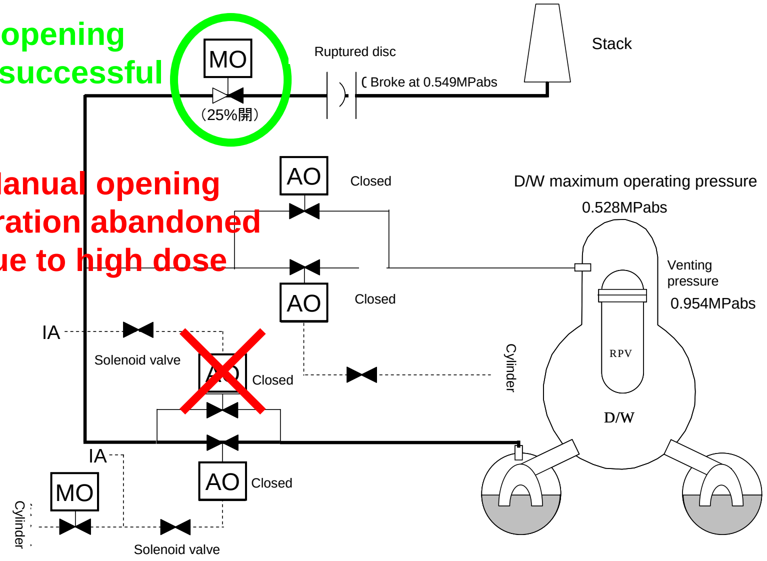
- The valve could not be operated from the main control room due to power losses, thus it was decided to open it manually in the field.
- The first team reached the PCV venting valve (MO valve) located on the 2nd floor of R/B and manually opened the valve in the field.

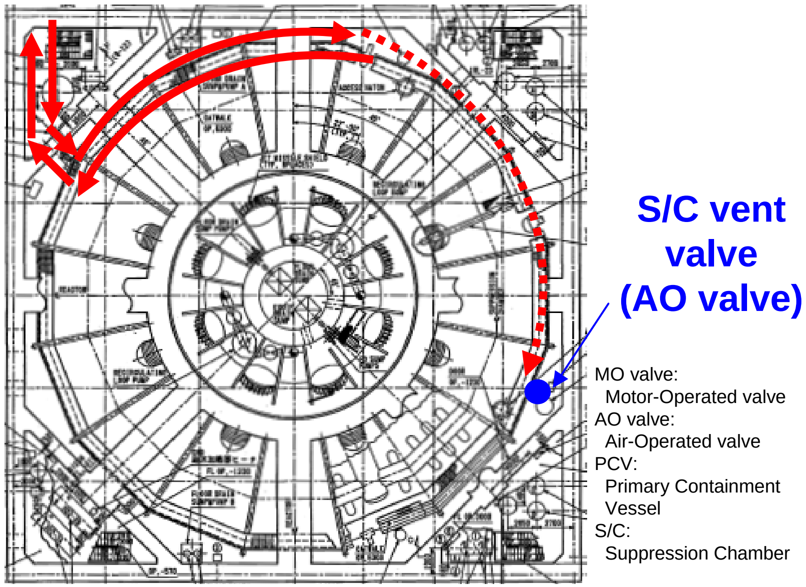
➡ Opening of PCV venting valve (MO valve) completed

Manual opening of S/C venting valve (small AO valve)

- The valve could not be operated from the main control room due to the loss of power supply and air pressure, thus it was decided to open it manually in the field.
- The second team entered the Torus room (R/B B1F), but the valve was located at the opposite side from the entrance.
- Since the radiation meter exceeded its measurable limit, the operators had to give up and return.

➡ Decided to give up the manual operation for venting and to choose another method（to connect a portable compressor and generator etc.）





MO valve: Motor-Operated valve
AO valve: Air-Operated valve
PCV: Primary Containment Vessel
S/C: Suppression Chamber

R/B B1F
Access route to S/C vent valve (AO valve)

Field Operation Difficulty

Field operation difficulties increased due to the aftershocks, the risk of tsunamis, and obstacles from the tsunami debris interrupted the outdoor work and also lighting was lost due to AC power loss.

Subsidence of roads etc.

Dangerous to walk in, especially at night

Obstacles

Detours to avoid fire truck hoses etc. After the explosion, debris and damaged fire trucks became obstacles.

Vice operation manager during monitoring

Monitoring with a full-face mask on in complete darkness.

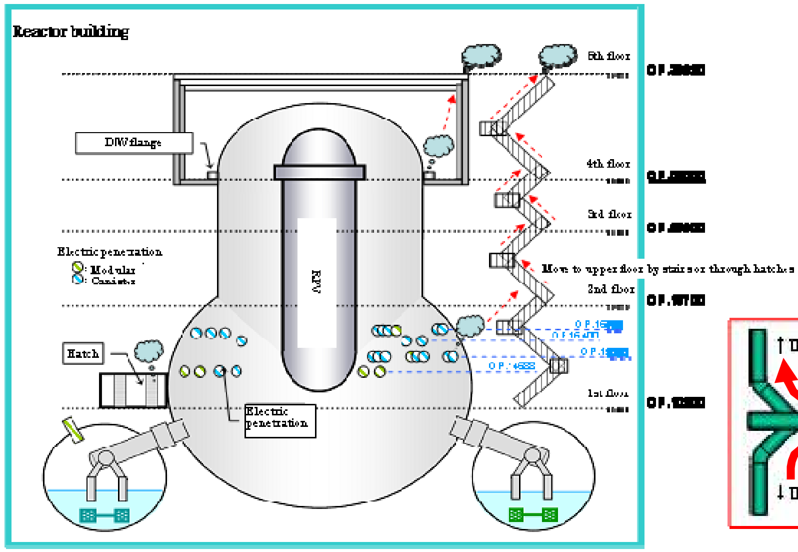
Temporary battery for instruments

Utilized temporary battery etc. for the power source of the instruments

Cause of Hydrogen Explosion

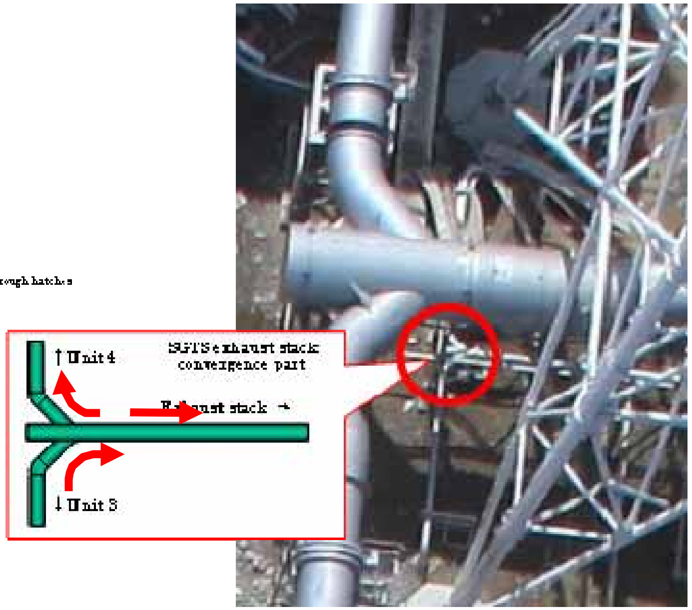
The evaluation of the hydrogen explosion at Fukushima Daiichi is as follows.

- Unit 1 & 3: Hydrogen generated from the damaged reactor fuels without cooling function accumulated in the PCV, leaked into the Reactor Building and then exploded.
  (It is estimated that inert gas (nitrogen) was properly inserted and thus the explosion inside the PCV was able to be avoided.)
- Unit 4: Hydrogen leaked and accumulated from the neighboring Unit 3 through the Standby Gas Treatment System (SGTS) piping while it was venting and then it exploded.
- Unit 2: It is estimated that the air ventilation inside the building was stimulated when the blow-out panel on the top floor burst open due to the explosion of Unit 1 and thus an explosion was avoided.



There are possibilities that the inferred leakage flow paths differ between Unit 1 and 3 according to system configuration

Units 1 & 3 Image of leakage path



SGTS pipe

Opening the Unit 2 blowout panel

II. Circulating Water Cooling

Before Circulating Water Cooling

- High-level contaminated water spilled out to the Unit 2 intake. (2011.4.2)
- Contaminated water accumulated in the Central Radioactive Waste Treatment Building and was released into the ocean.(2011.4.4)
- Contaminated water spilled out through a pit near the Unit 3 intake.(2011.5.11)

Situation in the pit near Unit 3 intake

Increase of contaminated water accumulated in the basement of the Reactor and Turbine Buildings.

- Injected water into the reactors leaked through the damaged RPV and PCV into the basement of the buildings.

↓

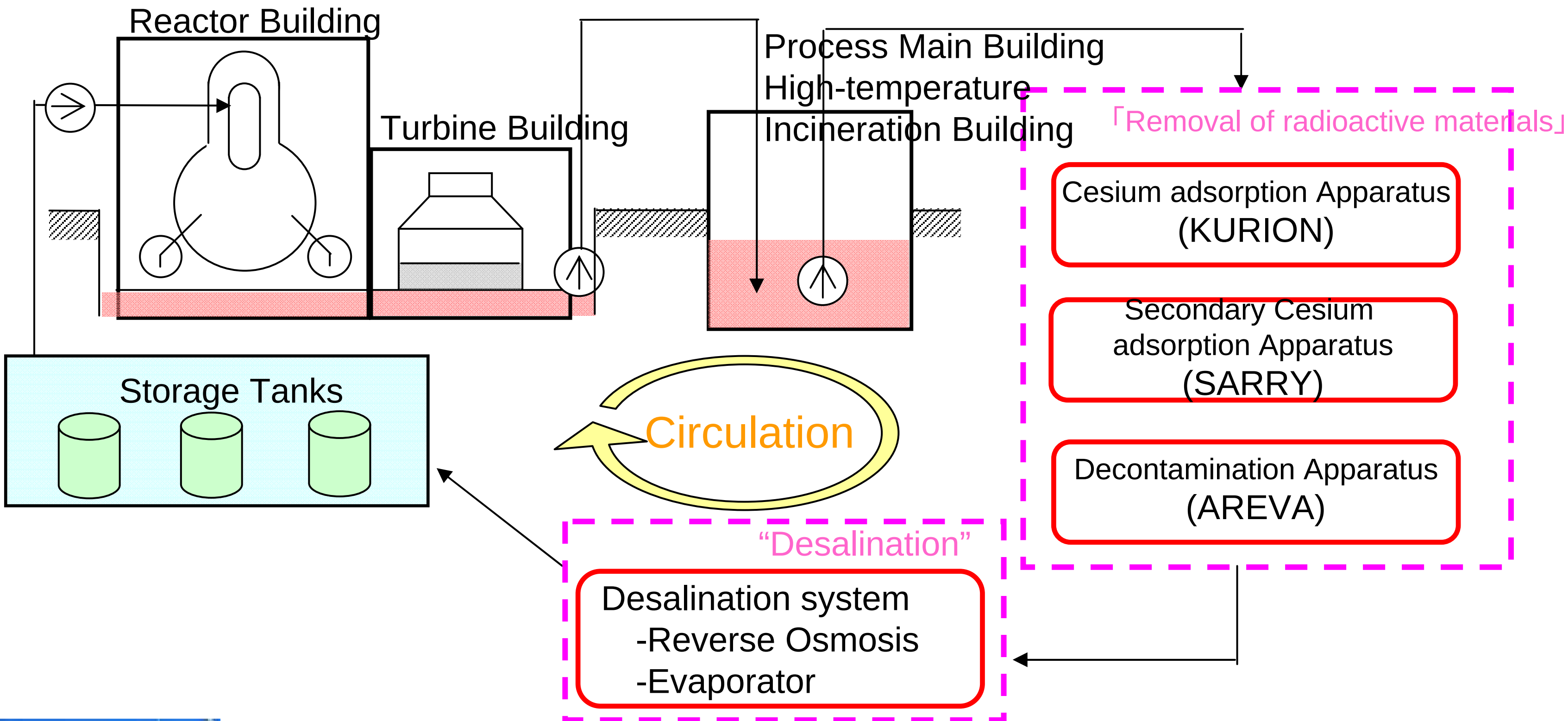
- Prevent the increase of accumulated water volume
- Reuse of contaminated water for injection into the reactors after treatment

↓

Establishment of Circulating Water Cooling System

Overview of Circulating Water Cooling (Water processing)

“Circulated cooling water injection” has been established to reuse the contaminated water in the buildings (accumulated water) for injection into the reactors (since 2011/6/27.)



Evaporator

Reverse Osmosis

Decontamination

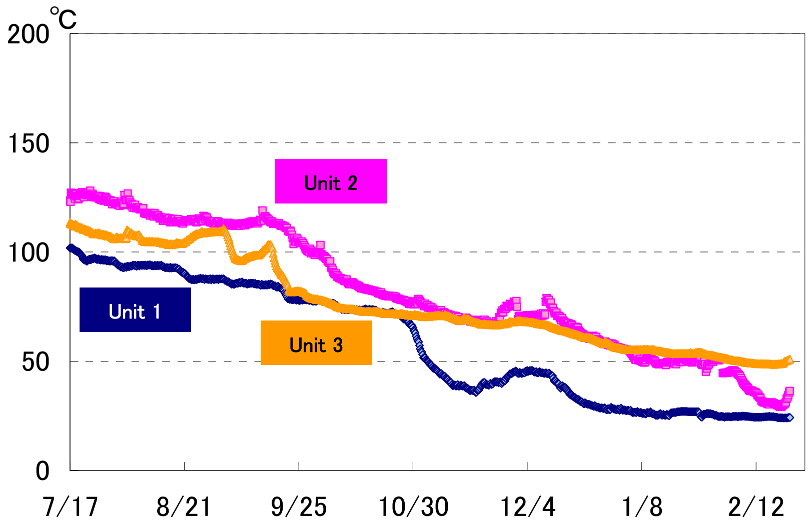
2nd Cs adsorption

Cs adsorption

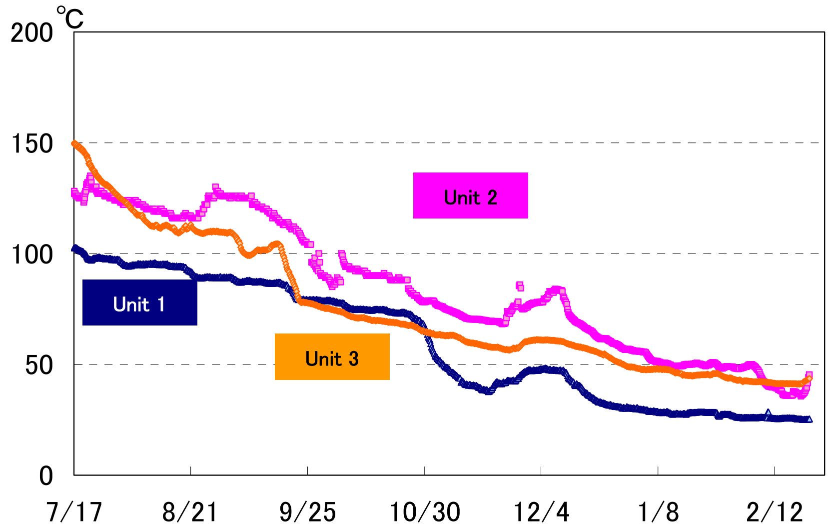
Achievement of "Cold Shutdown Conditions"

Temperatures of the RPV bottom and inside PCV are stable below 100 degree Celsius via the Circulating Water Cooling.

Temperatures of RPV bottom

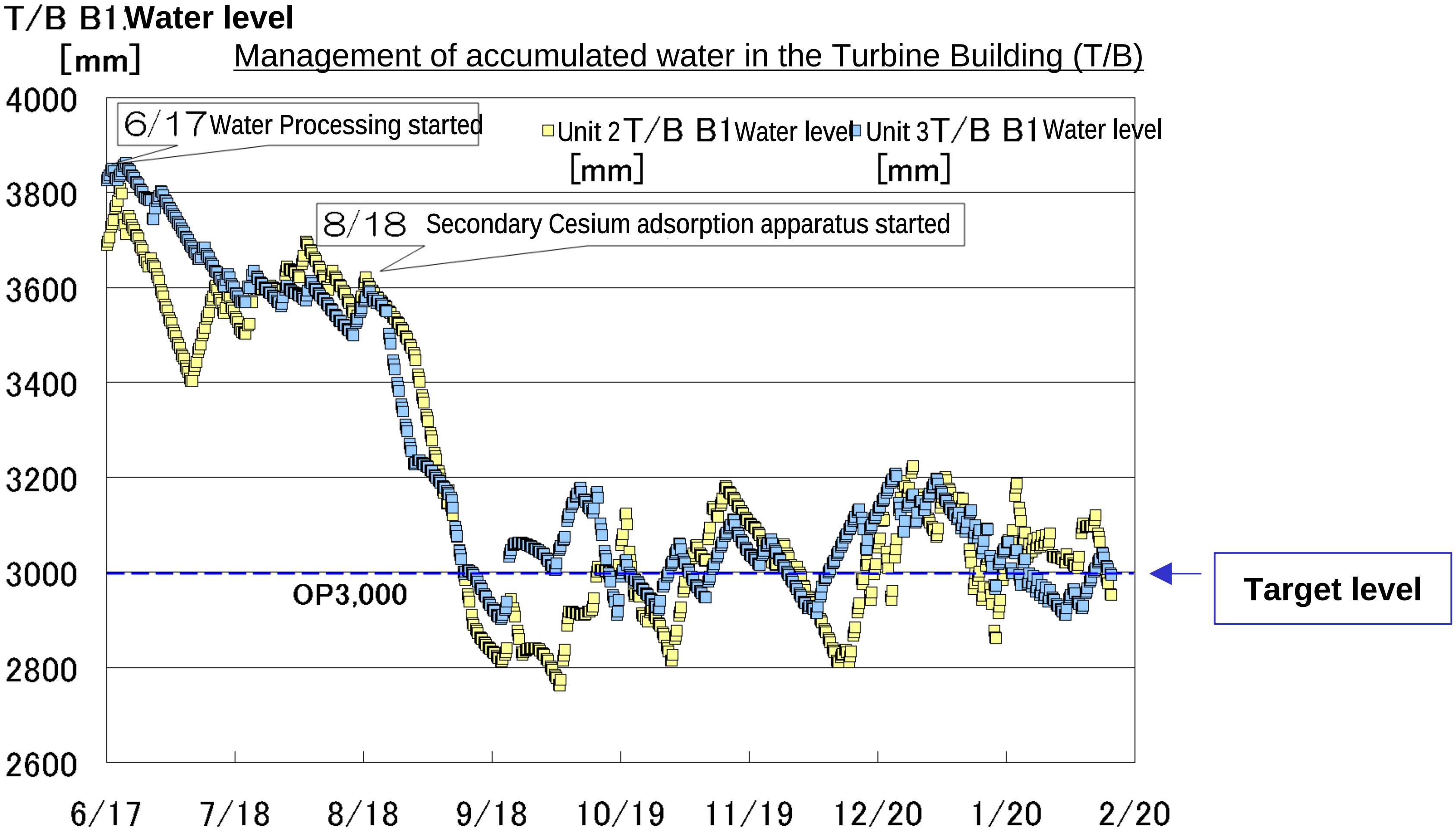


Temperatures inside PCV



Level of Accumulated Water Maintained as Targeted

The level of accumulated water is being maintained so that the water does not overflow to the outside of the buildings with heavy rain and the long-term shutdown of the processing facilities.



OP：Onahama Pile
(0.727m below the average sea level in Tokyo Bay)

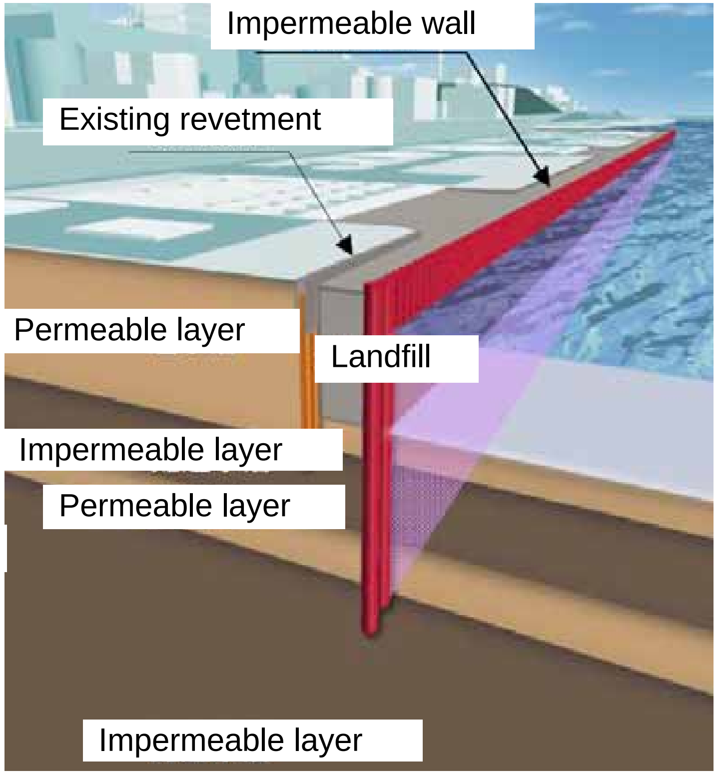
Preventing the Spread of Contamination to the Ocean

To prevent the spread of contamination to the ocean in case the underground water becomes contaminated, an impermeable wall is under construction in front of Units 1 to 4. It is scheduled to be completed within the 2014 fiscal year.

Image of the impermeable wall

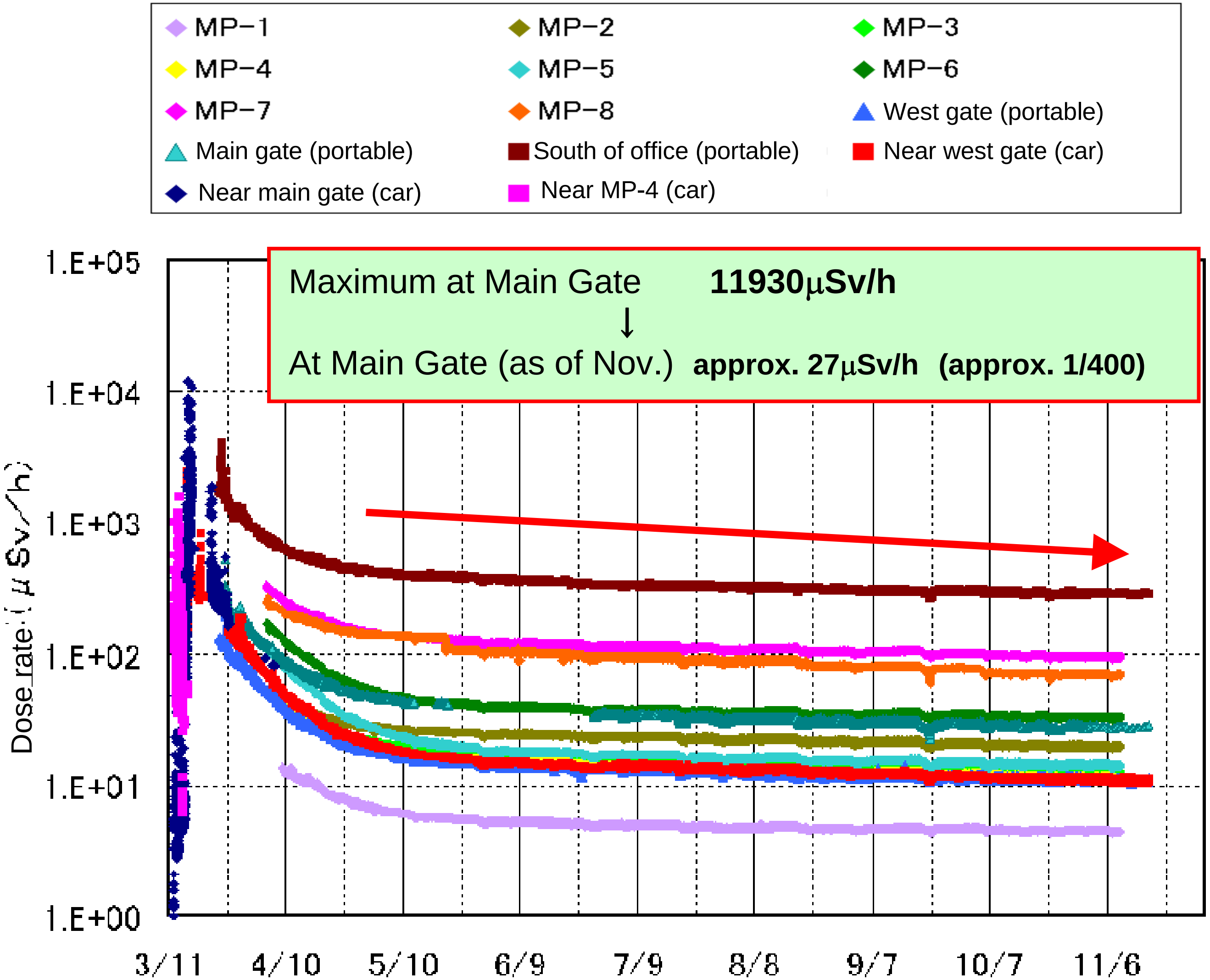
Overview

Cross-section



III. Mitigation of Radioactive emission

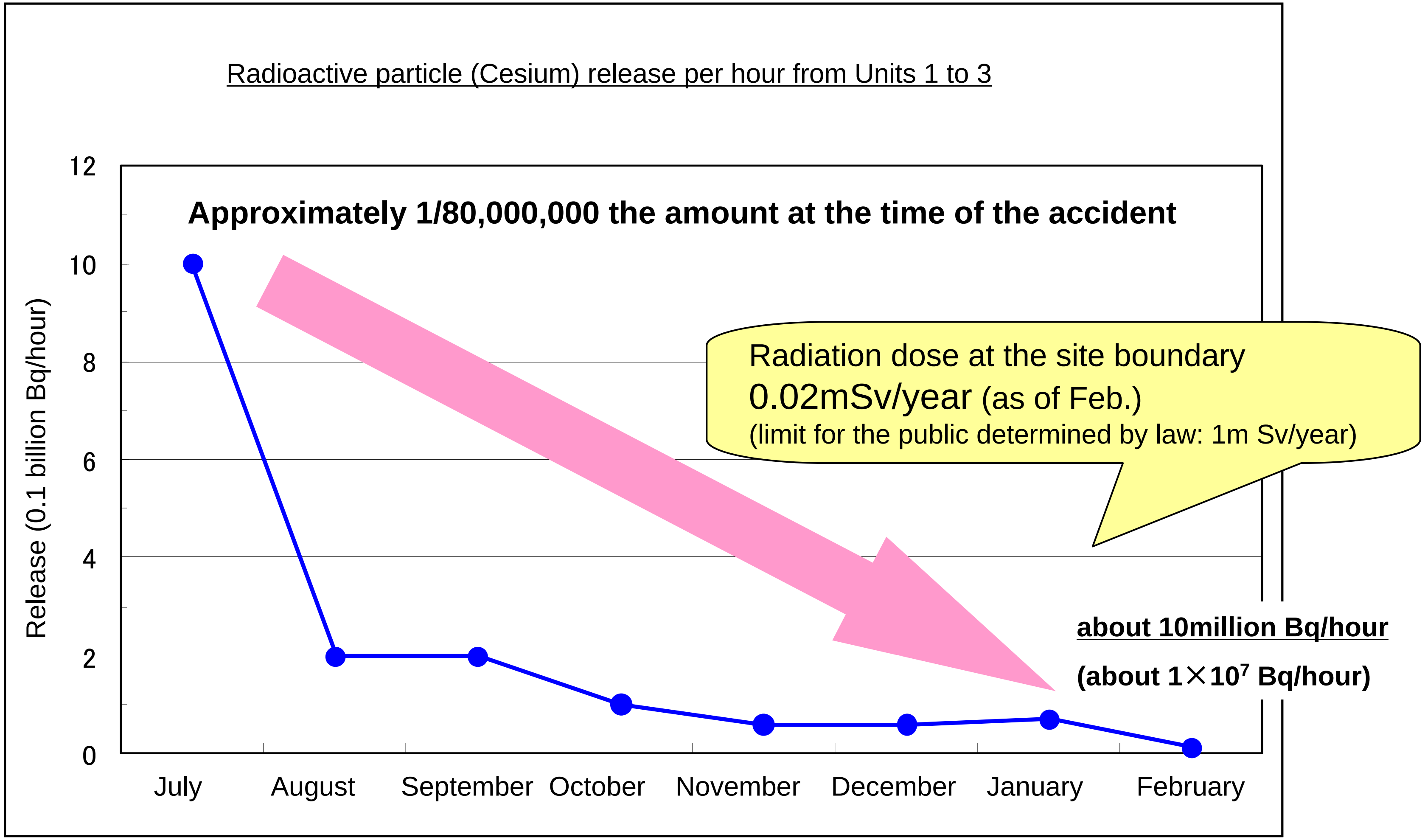
Radiation Dose Rate of Monitoring Posts etc.



The radiation dose rate was rapidly increased at each point after the accident, but since then it has been in a stable declining trend and is now approximately the background level at each point.

Mitigation of Radioactivity Particle Release

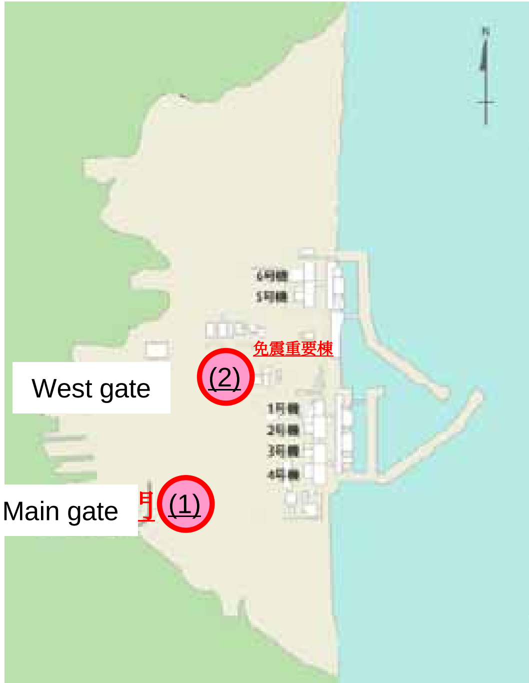
Radioactive particle (Cesium) release per hour from Units 1 to 3

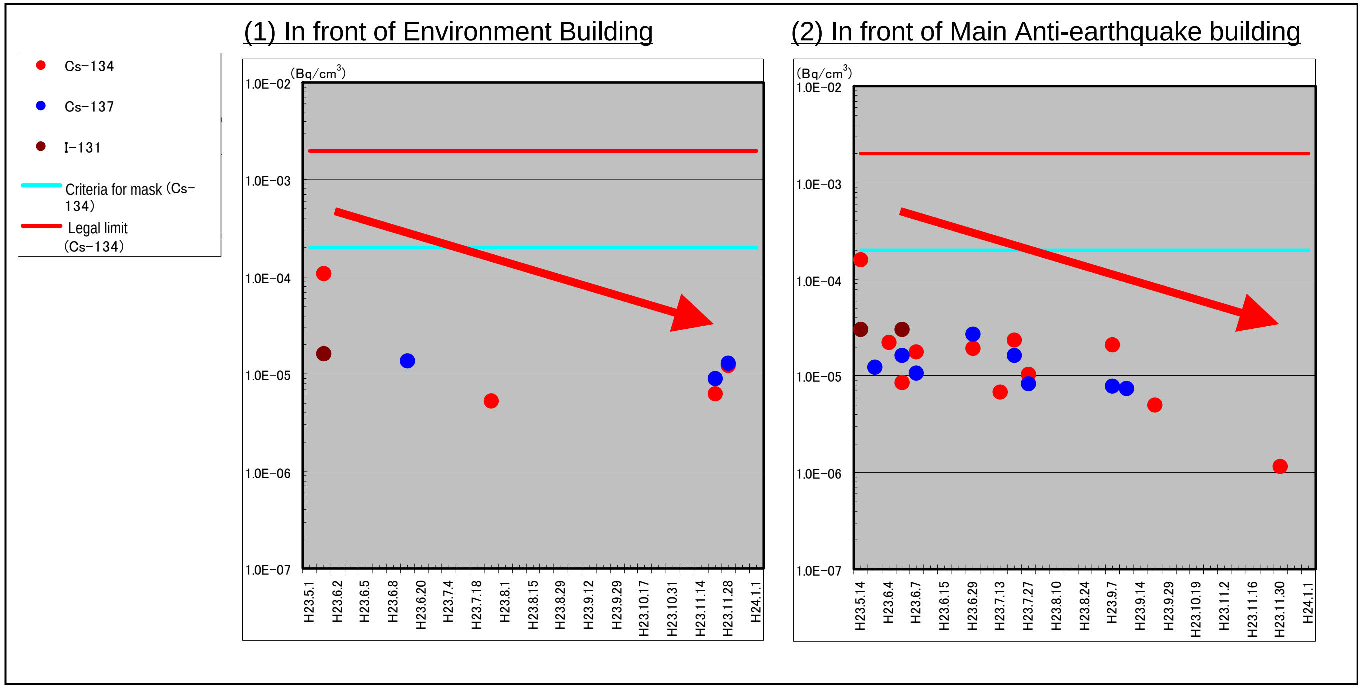


-What is Bq?-

Unit for radioactivity. 1 Bq is the radioactivity where 1 nucleus decays per second with radioactive ray. (Source: Nuclear Disaster Prevention Glossary released by MEXT)

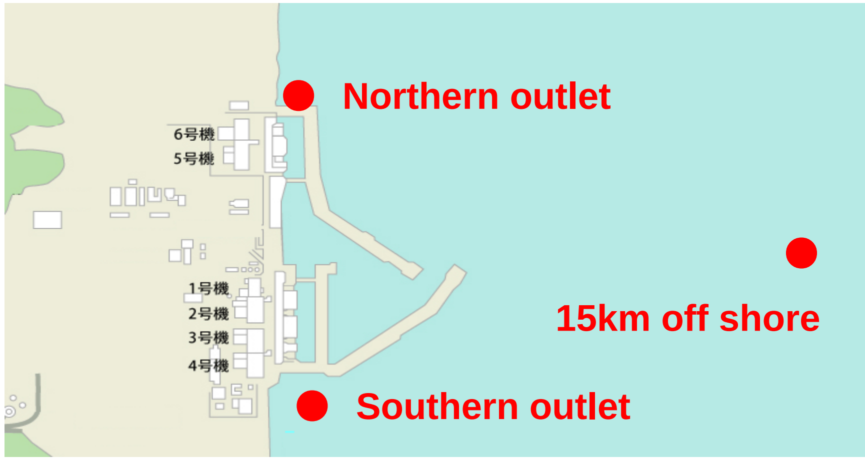
Radioactivity concentration inside the power station

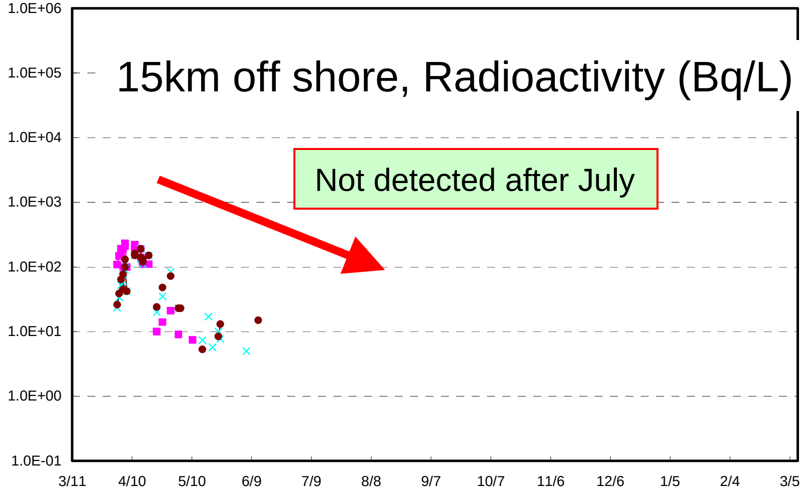




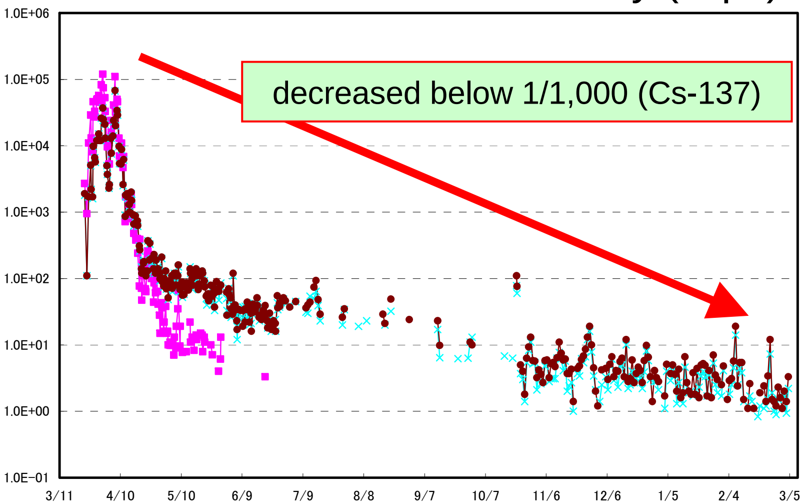
Radioactivity has exhibited a declining trend since the accident, and is now below the legal limit or the criteria requiring that masks be worn. Thus, the management of full-face masks and Tybeks has been simplified since March 1st, 2012.

Radioactivity concentration in the ocean (Onshore and offshore)

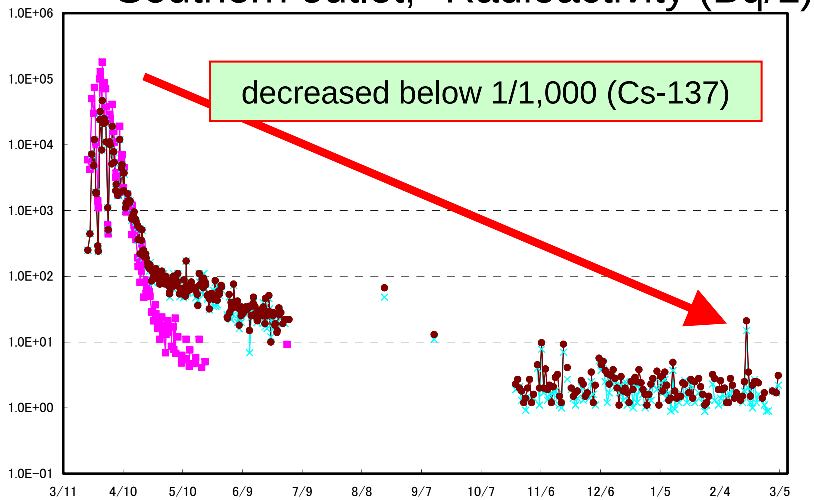




Northern outlet, Radioactivity (Bq/L)



Southern outlet, Radioactivity (Bq/L)



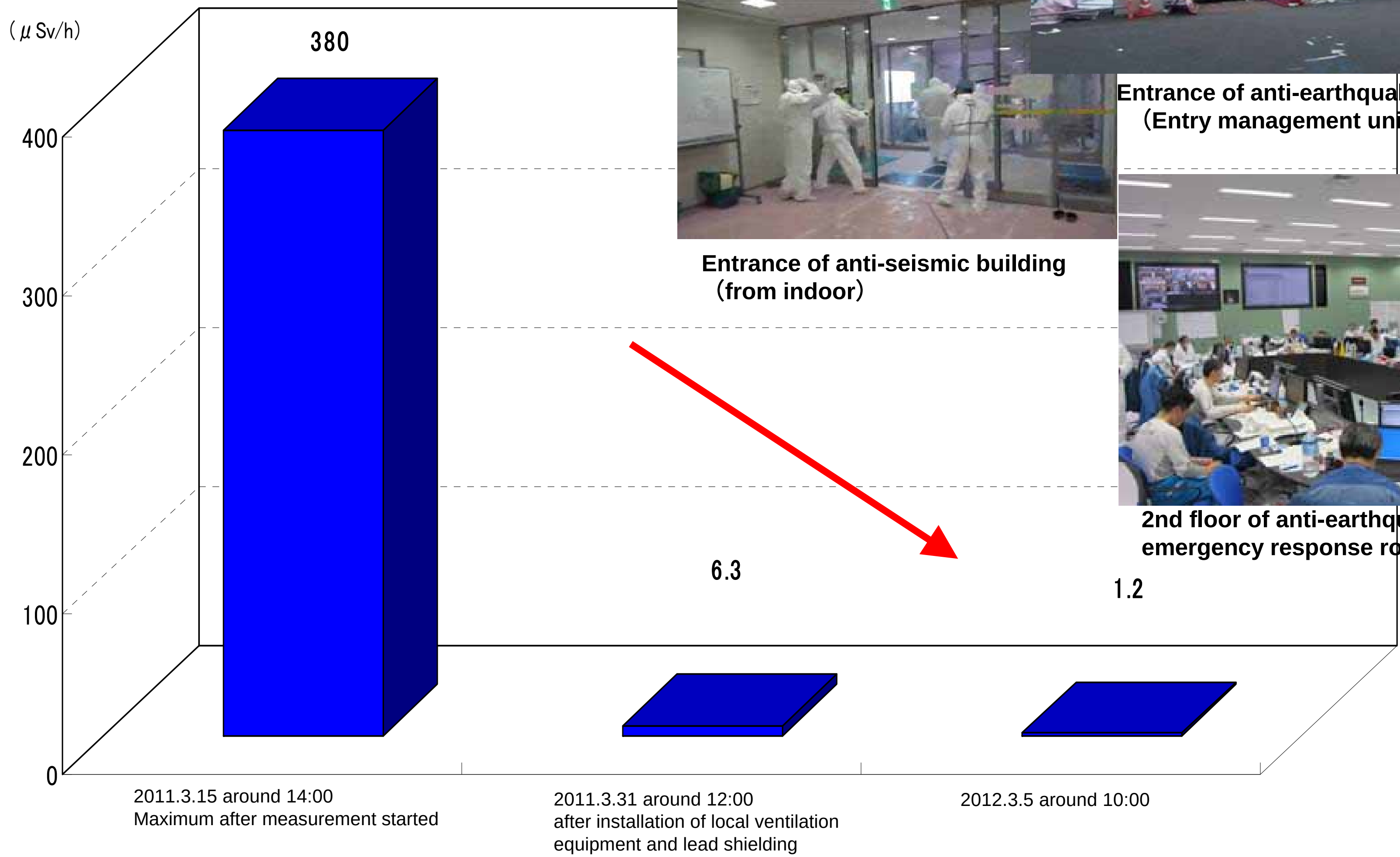
*Scale Vertical: 1E-1 ~ 1E+6 Horizontal: 2011/3/11 ~ 2012/3/5 *Legend I-131 Cs-134 Cs-137

In a declining trend since the accident, and now below a noticeable level.

*Notice level：Legal limit I-131…40 Cs-134…60 Cs-137…90 (Bq/L)

Radioactive dose rate at the Anti-seismic building

Radioactivity dose levels has been decreased due to environmental improvements inside the anti-seismic building.



Entrance of anti-earthquake building (Entry management unit house)

Entrance of anti-seismic building (from indoor)

2nd floor of anti-earthquake building emergency response room

Dose rate at Emergency response room on 2nd floor of anti-seismic building (Maximum point in the room)

IV. Preparations for Future Event

(Countermeasures against the earthquake and tsunami)

Plant Evaluation of the Earthquake's Impact

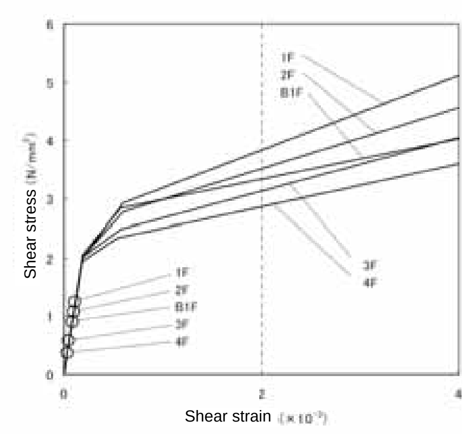
The seismic resistance of reactor buildings was analyzed against future large earthquakes based on the seismic ground motion according to the seismic design review standards and the actual building damages, although Units 1, 3 and 4 were damaged due to the hydrogen explosion. As a result, it has been confirmed that there is enough margin to satisfy the criteria and the reactor buildings have a sufficient seismic safety margin against future large earthquakes.

Result of seismic analysis of Units 1 to 4

Unit: N/A

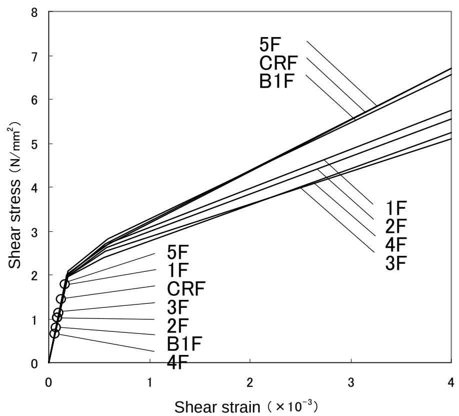
	Unit 1		Unit 2		Unit 3		Unit 4	
	calculation	criteria	calculation	criteria	calculation	criteria	calculation	criteria
Reactor Buildings	0.12×10^{-3}	4×10^{-3}	0.17×10^{-3}	4×10^{-3}	0.14×10^{-3}	4×10^{-3}	0.17×10^{-3}	4×10^{-3}

Maximum response on shear skeleton curve



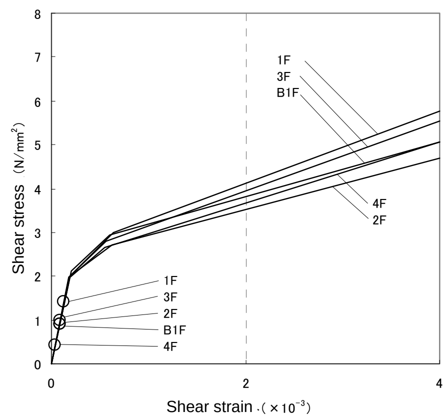
(Unit 1)

(Ss-1, NS direction)



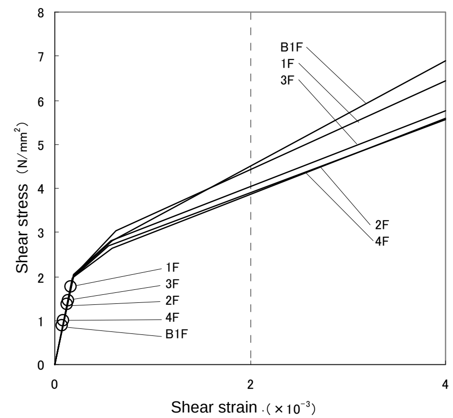
(Unit 2)

(Ss-1, EW direction)



(Unit 3)

(Ss-2, NS direction)



(Unit 4)

(Ss-1, EW direction)

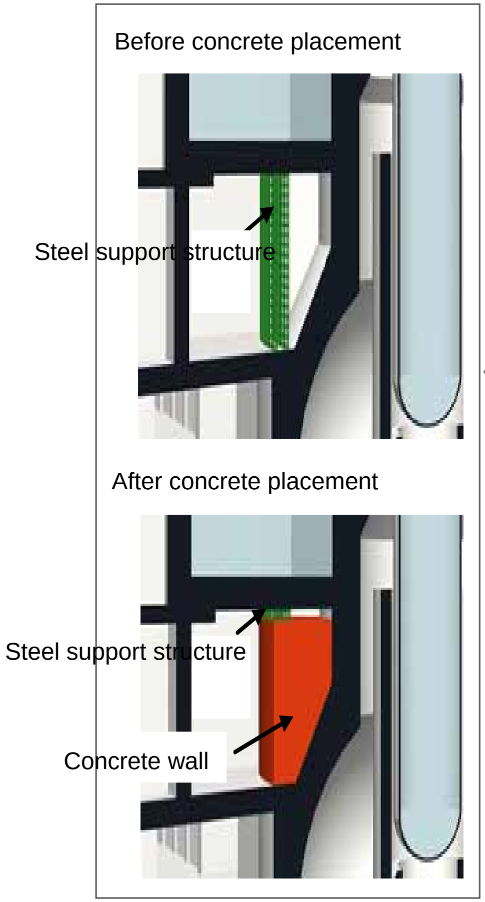
TEPCO

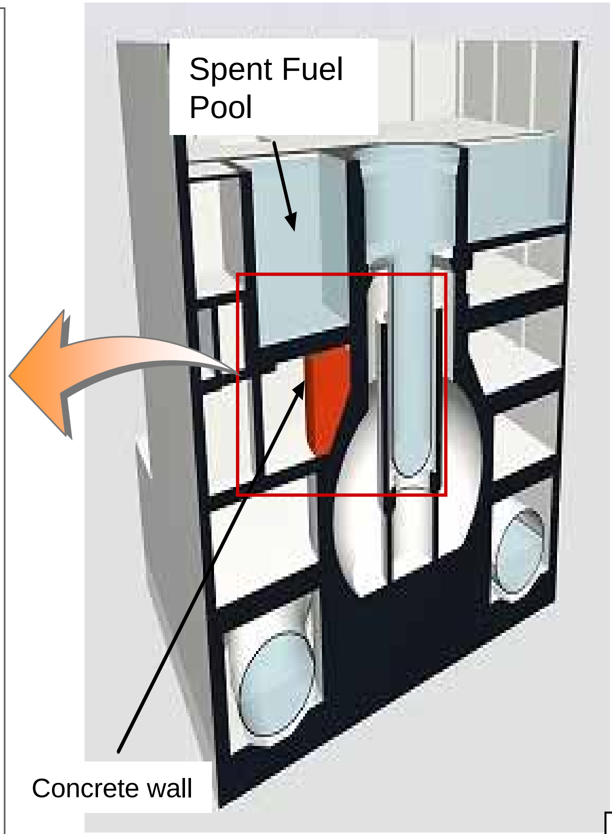
* It is estimated that the safety is secured in Units 5 and 6 of Fukushima Daiichi as a result of the same analysis.

Reinforcement of Unit 4 Reactor Building

Steel support structure (2011.6.20)

Concrete placement (2011.7.21)





Inside Spent Fuel Pool (2012.2.9)

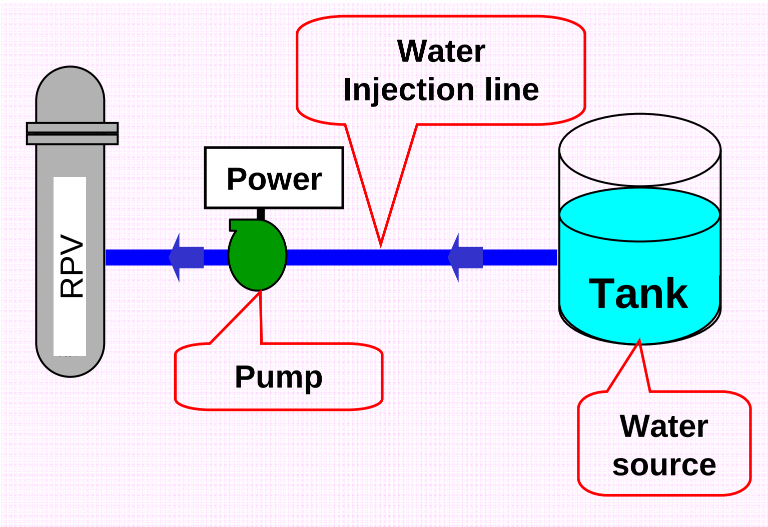
Installation of Temporary Coastal Barrier

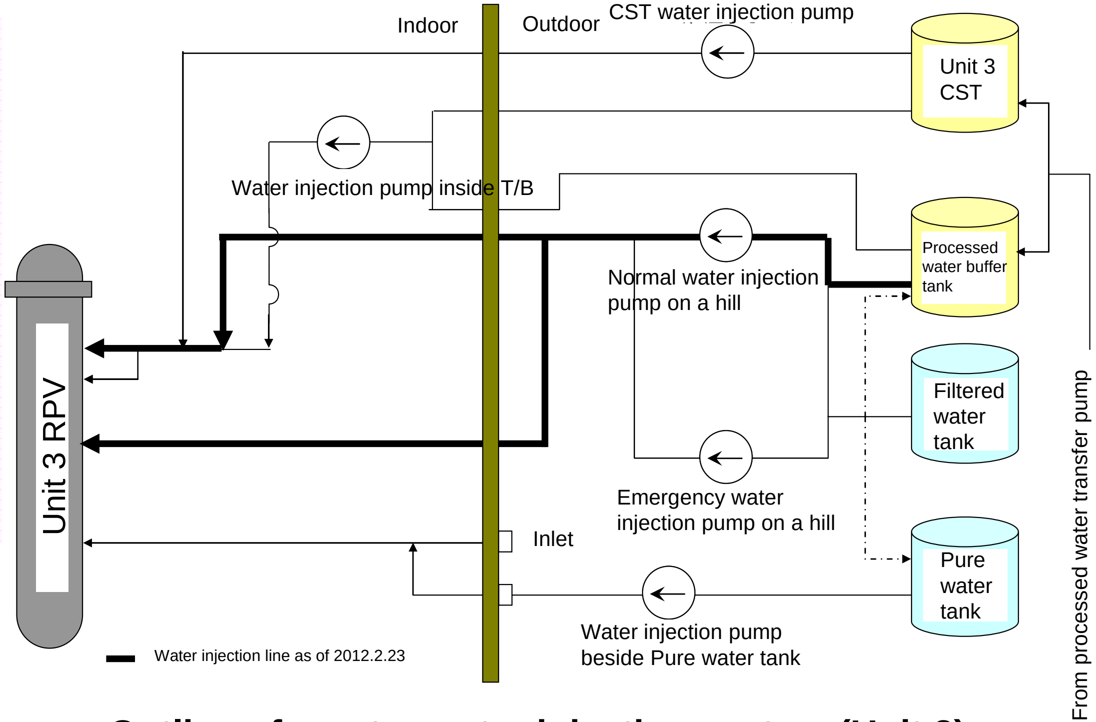
Temporary coastal barrier was installed as a countermeasure against tsunamis in case of a large aftershock of a magnitude 8 level.
(completed in June 30th 2011)

Installation work of temporary coastal barrier

Reinforcing the Water Injection System to the Reactor Core

The water injection systems to the reactor cores of Units 1 to 3 have redundancy and diversity with backups for water sources, pumps and water injection lines to secure stable water injection in case of an emergency shutdown of the facilities due to a blackout or large tsunami.





Outline of reactor water injection system (Unit 3)

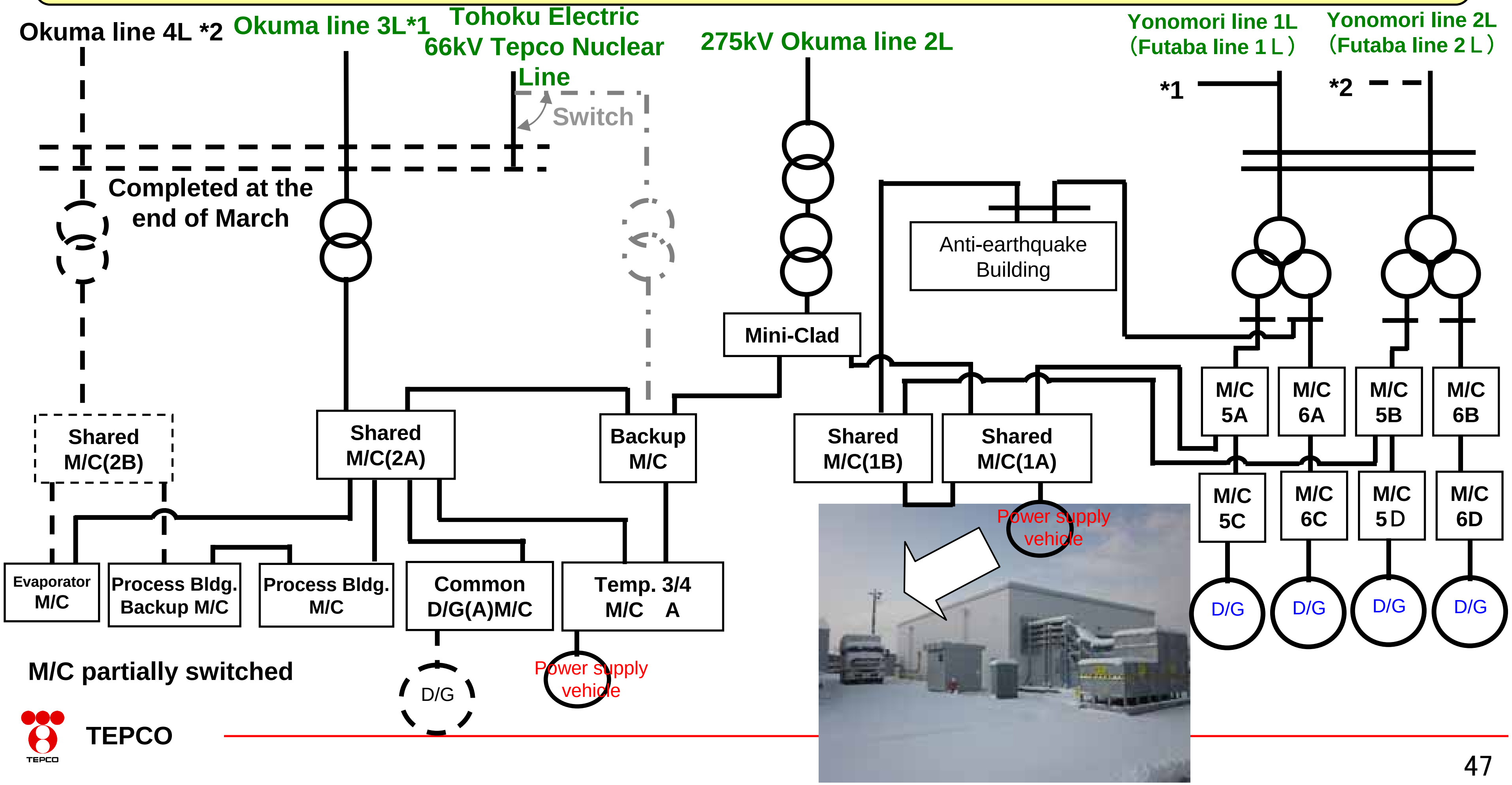
[Water injection pumps]

- 3 normal injection pumps on a hill
- 3 emergency injection pumps on a hill
- 3 pure water injection pumps
- 6 water injection pumps in T/B
- 4 CST injections pumps
- more than 10 fire trucks

Fire trucks on a hill

Reinforcement of Power Supply

Power supply has redundancy so that the electricity can be received either by the external power through the transmission lines or the diesel generators at the site. The external power has **5 transmission lines** available.（End of March: 6 lines） **4 diesel generators** are available (end of March: 5 D/G.) In addition, **2 power supply vehicles** have been deployed in the case of a blackout.



V. Misc. (Environmental improvements etc.)

Enhancement of the Medical Care System

Date：2011.9.6
Venue：Fukushima Daiichi Emergency medical room at Units 5 & 6
Service building 1st floor. (Front) medical space (Back) patient space

Date：2011.9.6
Venue：Fukushima Daiichi Emergency medical room at Units 5 & 6
Service building 1st floor. (Right) doctor (Left) nurse

Date：2011.9.6
Venue：Fukushima Daiichi Emergency medical room at Units 5 & 6
Service building 1st floor. (Right) doctor (Left) nurse

Date：2011.9.5
Venue：Fukushima Daiichi Entrance of Units 5 & 6 Service building
1st floor. Training for screening and decontamination for a patient

Installation of On-site Rest Stations

A total of 21 rest stations for approximately 1,800 people have been installed (as of March 7th).

Rest station（In front of an anti-seismic building）

Inside the rest station

Drinking water

Overview

Inside the rest station

Removal and Storage of Outdoor Rubble

Trying to improve the working environment and reduce the radiation dose exposure of workers by removing and storing the rubble. The removed rubble are stored separately according to its radiation dose.

[before] (1) In front of the Main Office

[Date] 2011.5.27

(2) Road between Units 2 and 3

[Date] 2011.5.3

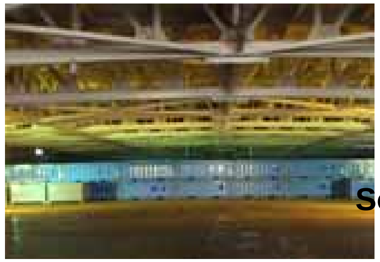
[after]

[Date] 2011.6.7

[Date] 2011.5.14

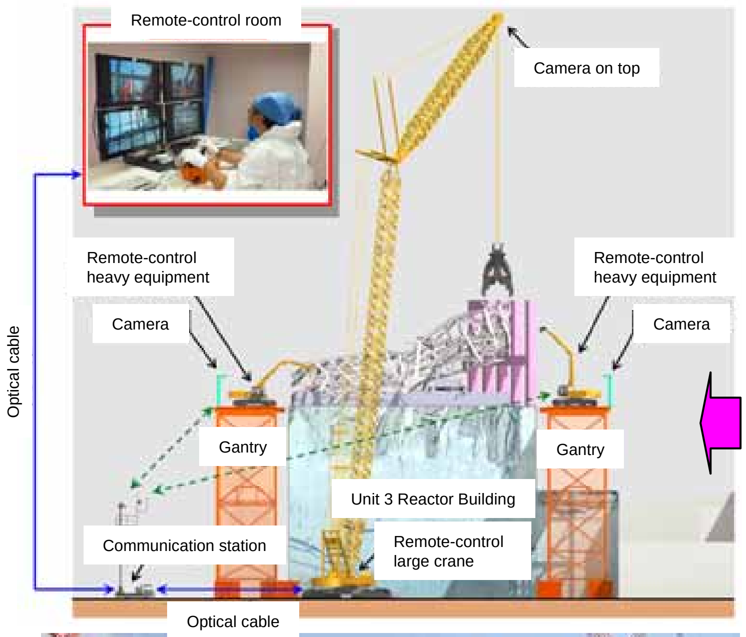
Rubble removal work using remote-control machine

Inside the tent



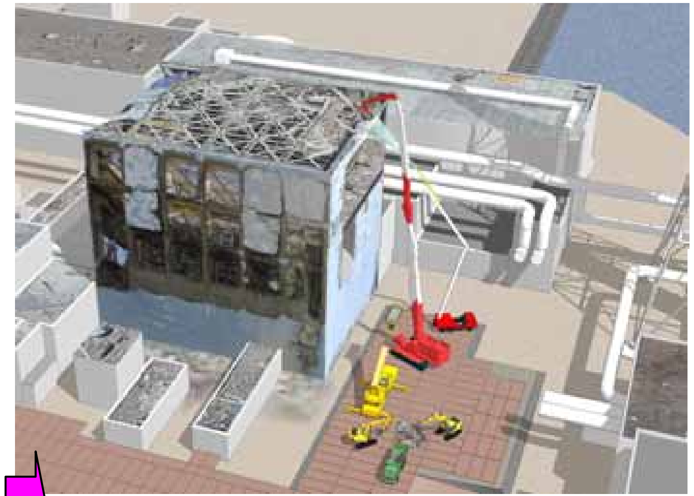
Solid waste storage building

Reactor Building Rubble Removal Work



To prepare for fuel removal from the Spent Fuel Pools, the scattered debris above the Units 3 & 4 reactor buildings are now being removed.

Unit 3 Rubble removal work above the reactor building is being carried out by the remote-control heavy equipment on the surrounding gantry or the ground to reduce the radiation dose of workers.



Unit 3 2012.2.21

Unit 4 Rubble removal work is carried out by manned heavy equipments on the ground since the radiation dose around the working area is relatively low.

Removal of Unit 4 crane garter 2012.3.5

End

Long and Mid term Roadmap

Will proceed with the long and mid term roadmap which indicates the schedule of main on-site works and R&D until the completion of decommissioning.

2011.12.16 Present (Step 2 completed)	Within 2 years	Within 10 years	30～40 years later
Step1, 2	Phase 1	Phase 2	Phase 3
<Stabilization> - Cold shutdown condition - Effective mitigation of release	Until start of fuel removal from Spent Fuel Pools (within 2 years)	Until start of fuel debris removal (within 10 years)	Until decommissioning completed (30 ~ 40 years later)
	・Start of fuel removal from Spent Fuel Pools (Unit 4, within 2 years) ・Reduction of the radioactivity from additional release from the power station and radioactive waste (water processing by-product and debris etc.), with effective radiation dose at the site boundary below 1 mSv/year. ・Continuous safety and reliability improvement of reactor cooling and accumulated water processing. ・Start of technology development and decontamination work for fuel debris removal ・Start of R&D for radioactive waste treatment and disposal	・Completion of fuel removal from Spent Fuel Pools of all Units ・Completion of preparation for decontamination inside buildings, PCV repair & flooding and fuel debris removal. Start of fuel debris removal (within 10 years as a target) ・Stable and continuous reactor cooling ・Completion of accumulated water processing ・Continuous R&D for radioactive waste treatment and disposal. Start of R&D for decommissioning	・Completion of fuel debris removal (20 ~ 25 years later) ・Completion of decommissioning (30 ~ 40 years later) ・Implementation of radioactive waste treatment and disposal

Systematic staff training and allocation, motivation improvement, and efforts to secure safety (Continue)

* Debris：Pellet and cladding tube melted then solidified

We deeply apologize for the trouble and anxiety that has arisen due to the Fukushima Daiichi Nuclear Power Station Accident.

We will continue with our efforts to maintain stable cooling conditions and work towards the decommissioning of the reactors per the long-and-mid term roadmap while always keeping in mind that safety must be our top priority.