The Present Status and the Future Of Fukushima Daiichi NPS

April 18th, 2012

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Tokyo Electric Power Company

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The Earthquake and the Tsunami of the 3/11/2011

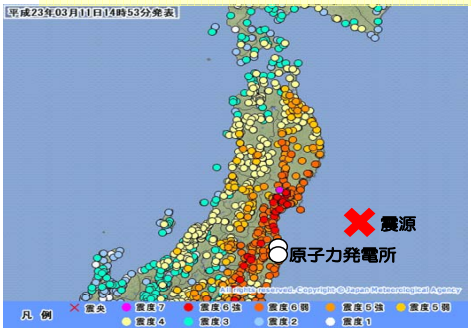
Time: 2:46 pm on Fri, March 11, 2011.

Epicentre: Offshore Sanriku coast (38° N, 142.9° E), 24km in depth, Magnitude 9.0

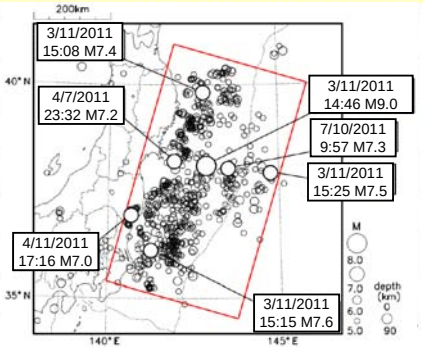
Intensity: **Level 7** at Kurihara in Miyagi prefecture

Upper 6 at Naraha, Tomioka, Okuma, and Futaba in Fukushima pref.

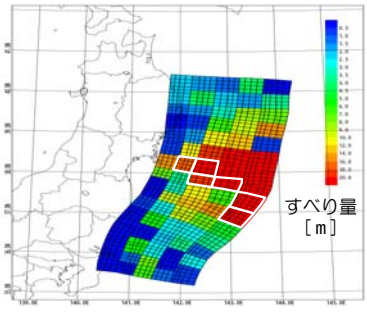
Lower 6 at Ishinomaki and Onagawa in Miyagi pref., Tokai in Ibaraki pref.



The Epicenter and Intensity



Source area of the Earthquake

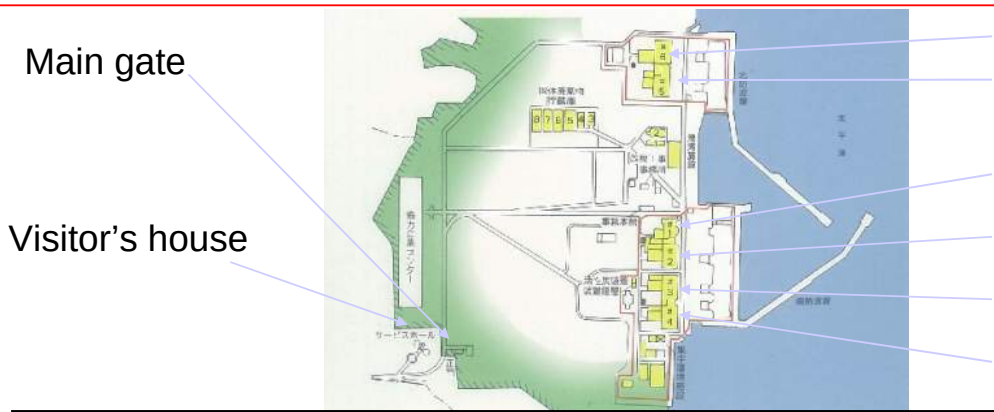


Tsunami Wave Sources

- The M9.0 earthquake, fourth largest in the world caused by a coupling movement of several separate seismic regions; the Off-shore Miyagi pref., the Southern Trench off-shore Sanriku east, the Off-shore Fukushima pref., and the Off-shore Ibaraki pref.

-Although the Governmental Research Authority, as well as TEPCO had evaluated seismic motion and tsunamis in individual regions by the scientific analyses, the coupling movement of all these regions had not been taken into account.

Outline of the Fukushima Daiichi NPS



Location	Unit	In operation since	Plant type	Power Output (MW)	Main Contractor	Pre-earthquake status
Ohkuma	1	1971.3	BWR-3	460	GE	Operating
	2	1974.7	BWR-4	784	GE/Toshiba	Operating
	3	1976.3	BWR-4	784	Toshiba	Operating
	4	1978.10	BWR-4	784	Hitachi	Shutdown for maintenance
Futaba	5	1978.4	BWR-4	784	Toshiba	Shutdown for maintenance
	6	1979.10	BWR-5	1100	GE/Toshiba	Shutdown for maintenance

Intensity of the earthquake at the power station

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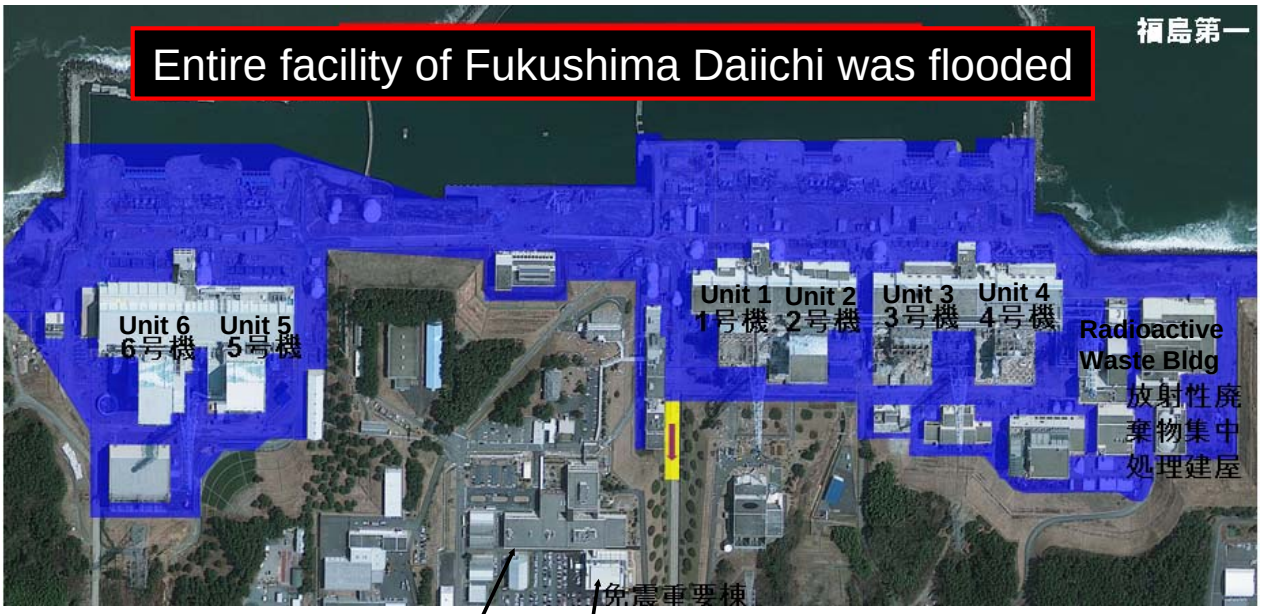
Most observed acceleration data was below that of the design-basis earthquake

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

*: The records were stopped approximately 130-150 seconds after recording started.

Height of the Tsunami at Fukushima Diichi(1)

6



(C)GeoEye

Height of the Tsunami at Fukushima Diichi (2)

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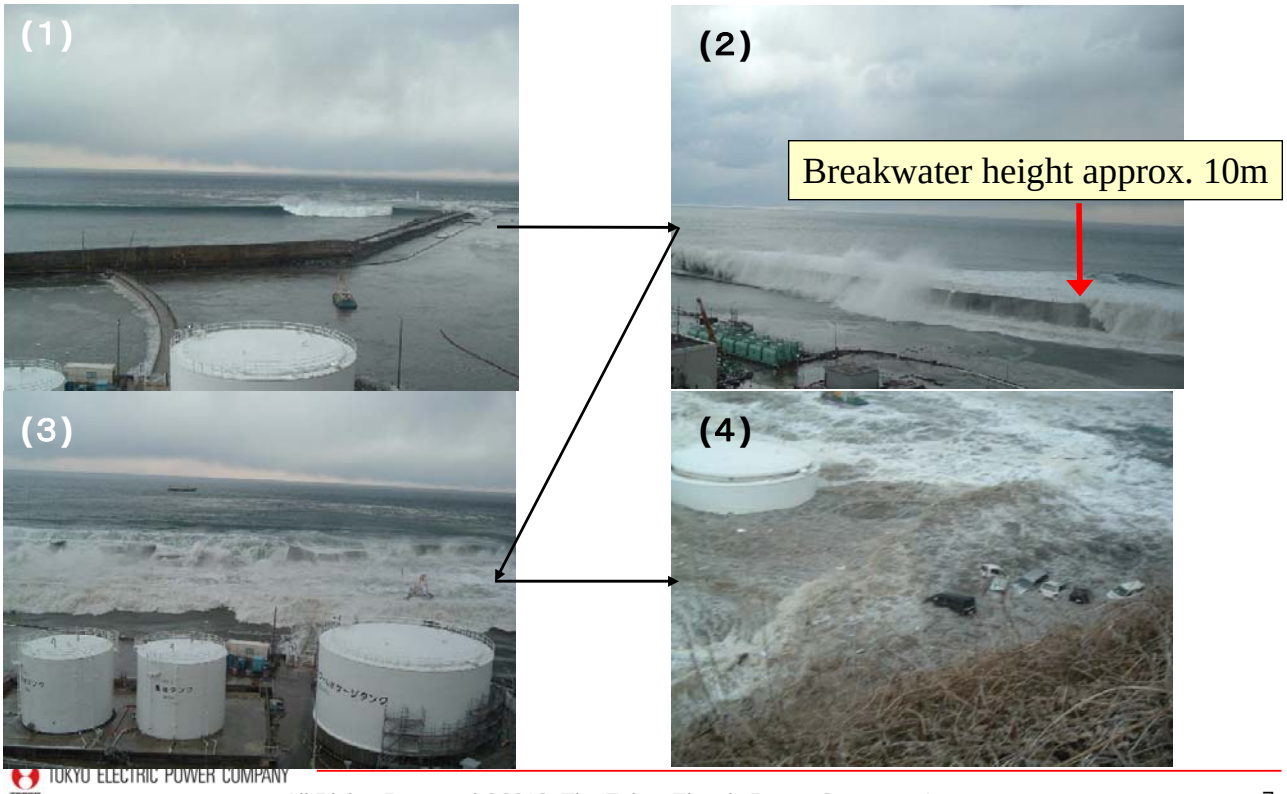
Photos taken from the Unit 5 and 6



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Height of the tsunami at Fukushima Diichi (3)

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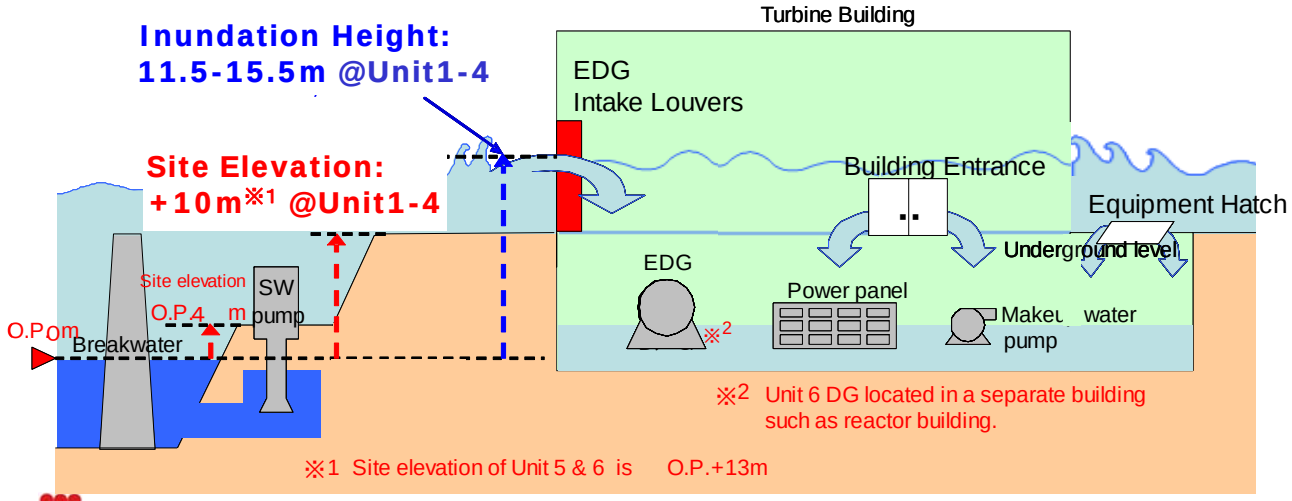
Major inundation pathways;
1. Building Entrance
2. Equipment Hatch
3. Emergency Diesel Generators Air Supply Louver Boards
4. Trenches, Ducts (cable penetrations), etc.

⇒Inundation to Rooms for Emergency Diesel Generators & Electric Panel



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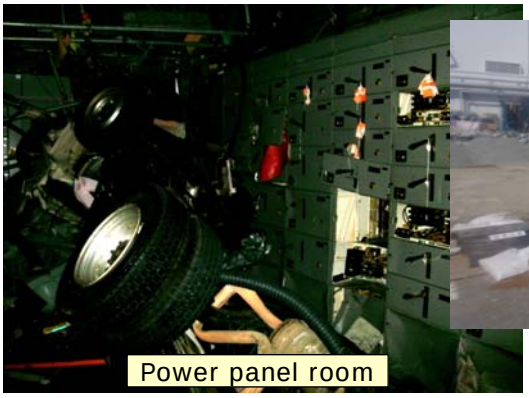
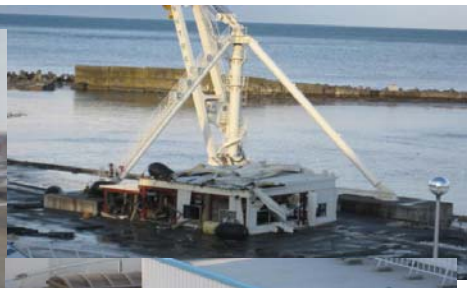
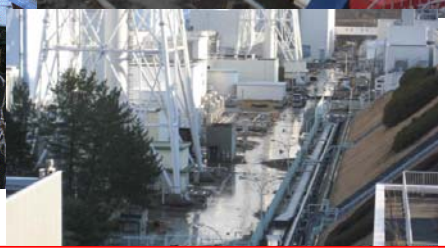
Height of the tsunami at Fukushima Diichi (4)

9



Power panel room





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Emergency Response - Main Control Room

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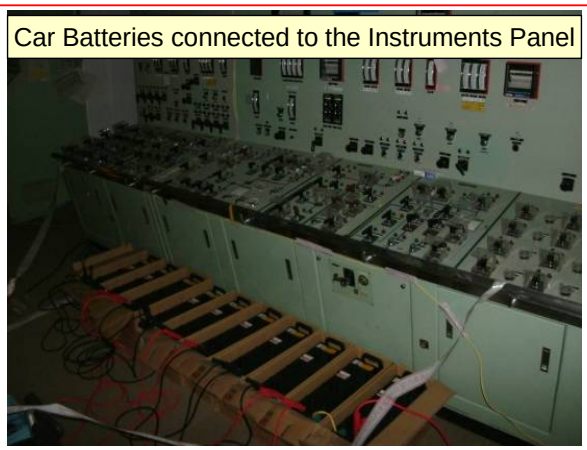
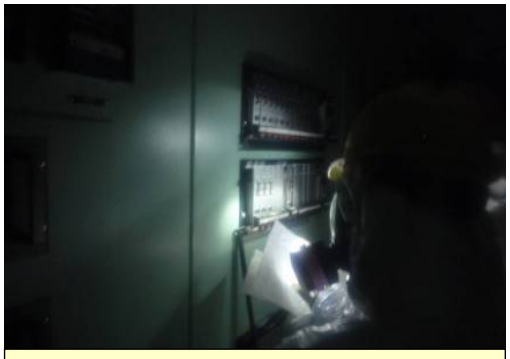
Car Batteries connected to the Instruments Panel





instrument Reading with a flashlight

Deputy Shift Superviser

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Emergency Response – Alternate Water Injection

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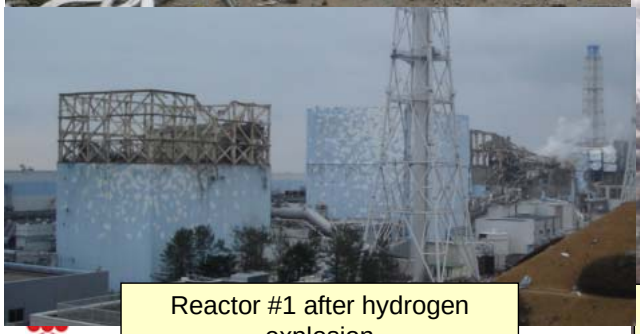
Fire truck and scattered driftage

Wide-open cracks on the road blocking the transportation



Reactor #1 after hydrogen explosion

Heavy oil tank washed away by the tsunami and blocking the road

Emergency Response – Inside Emergency Response Center

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Emergency Response HQ in the anti-seismic building

Emergency Response HQ packed with people immediately after the accident

Entrance of the anti-seismic building

After Evacuation to Emergency Response Center

Radiation Control

・6 TEPCO employees exceeded the exposure dose of 250mSv including one who exceeded 670mSv due to post-accident water injection and vent work.
・99 TEPCO employees and contractors exceeded 100mSv.
・No reports of health issues due to acute radiation damage as of present.
(Emergency dose limit for radiation workers was increased to 250mSv after March 14, 2011, now is resumed to100mSv.

Screening

Training

Restoration Work -STEP1

Water Injection to Spent Fuel Pool

Contaminated Water Treatment
–Installation of Cesium Absorption Units

Storage Tank for
Contaminated Water

Spraying Dust Inhibiter

Installation of Processed Water Tank

Company Houses at J-Village

Restoration Work –STEP2

Desalination plant for Spent Fuel Pool Water

Evaporator / Condenser

Low-Rd Debris Storage

Installation of Reactor Building Cover

PCV Gas mgt System

Establishment of Site Medical System

Restoration Work –Countermeasure for Aftershocks and Tsunamis

Alternative Water Injection

Restoration of Breakwater

Installation of Seawall

Summery of the Step 2 Completion of "Roadmap towards Restoration from the Accident"

- Confirmed the reactors were brought to a condition equivalent to "cold shutdown" and stabilized (in case an accident occurs, we will be able to keep the radiation dose at the site boundaries at a sufficiently low level)
- The targets other than reactors had been achieved as follows, thus the completion of the Step 2 "Release of radioactive materials is under control and radiation doses are being significantly held down" was confirmed.

Progress status of "Roadmap towards Restoration from the Accident at Fukushima Daiichi Nuclear Power Station" on December 16

[Issue (1) Reactors]: Achieved "condition equivalent to cold shutdown"
RPV bottom temperatures and internal PCV temperatures are , in general, below 100 ℃. Release of radioactive materials from PCV is under control and public radiation exposure by additional release is being significantly held down. The mid-term safety of the circulating water cooling system is secured.

[Issue (2) Spent fuel pools]: Achieved "more stable cooling"

[Issue (3) Accumulated water]: "Total volume of accumulated water has been reduced"

[Issue (4) Groundwater]: The start of water shielding wall construction marked the achievement of Step 2

[Issue (5) Atmosphere/Soil]: Unit 1 reactor building cover completion marked the achievement of Step 2.

[Issue (6) Measurement, Reduction, Announcement]: Full fledged decontamination work has begun according to the cabinet decision of the basic policy based on the Special Act

[Issue (7) Tsunami, Reinforcement, etc.]: Seismic safety assessment of the reactor buildings has completed in all Units. A support structure at the bottom of the Unit 4 Spent Fuel Pool has been installed.

[Issue (8) Living/working environment]: Living/working environment has been improved via the construction of temporary dormitories and on-site rest stations.
Improved working environment that was harsh in the immediate aftermath of the accident via providing healthier meals, installing bathing & laundry facilities, and setting up temporary dormitories & on-site rest stations, thus maintaining worker motivation.:

[Issue (9) Radiation control/Medical care]: Health care has been improved via restoring appropriate radiation controls and organizing a medical care system, etc.
Countermeasures for medical care have been implemented: countermeasures against heatstroke and influenza, radiation control system reinforcements, thorough exposure control, consideration for long-term healthcare.

[Issue (10) Staff training/personnel allocation]: Continue staff training and continue to consider a strategy to effectively procure required staff
Promote staff training, especially for high-demand staff engaged in radiation work, in conjunction with the government and TEPCO.

[Action plan for mid-and-long term issues]: Confirmed that the mid-term safety of the circulating cooling system has been secure.
The facility operation plan in light of the mid-term safety was developed, followed by the government review. Hereafter, the government and TEPCO's mid-and-long-term countermeasure conference will be established, which will develop mid-and-long term roadmap and promote necessary on-site work and R&D towards decommissioning.

Cold Shutdown Status

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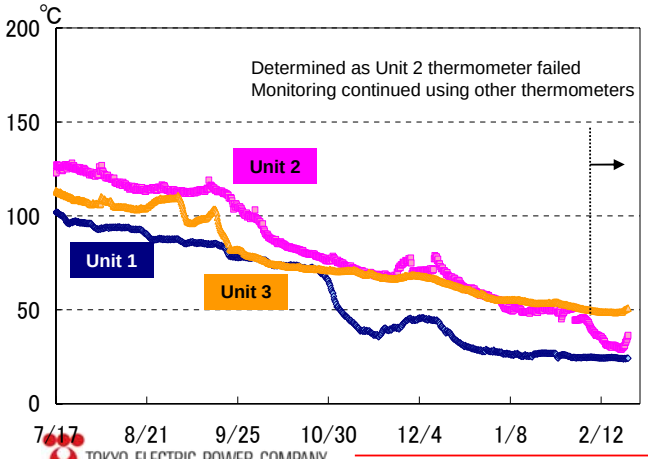
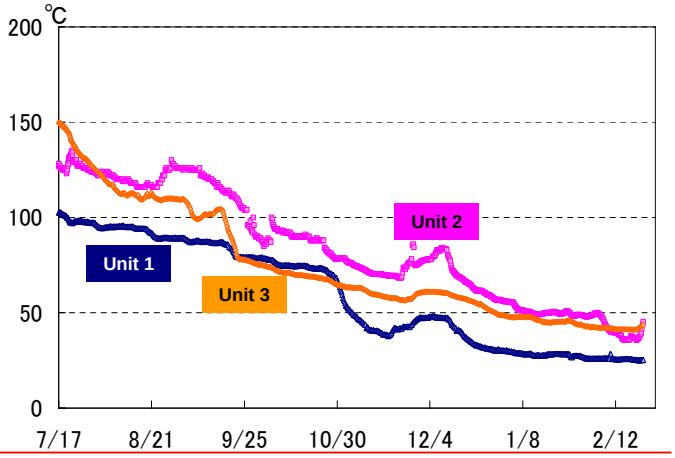
- **Circulating Water Cooling** continued (6/27/2011～)
  - ✓It is difficult to accurately understand where the damaged fuel is located in the RPV or PCV, but the **temperature at the bottom of RPV bottom and inside the PCV are stable at below 100℃.**
- Release of radioactive materials from containment vessel controlled
  - ✓**The release of radioactive materials from PCV is controlled and radiation dose is significantly reduced** by cooling the inside of the PCV and controlling steam generation.



RPV Bottom Temperature



Temperature in PCV

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Controlling the Release of Radioactive Materials

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- The amount of radioactive materials (cesium) released from Unit 1-3 PCV is calculated the assessed value of total release amount (as of February 13, 2012) as **about 10 million Bq/hr.**
  →**About one-80 millionth** compared to immediately after the accident.
- Accordingly, assessed the exposure dose at site boundary as **0.02mSv/yr. at maximum**.
  (Excluding effect of already released radioactive materials)
  Note: Exposure limit established by law is 1mSv/yr.

In front of the Emergency Response Centre

March 2012

Accumulated Water Treatment
～Controlling the Total Amount of Accumulated Water～

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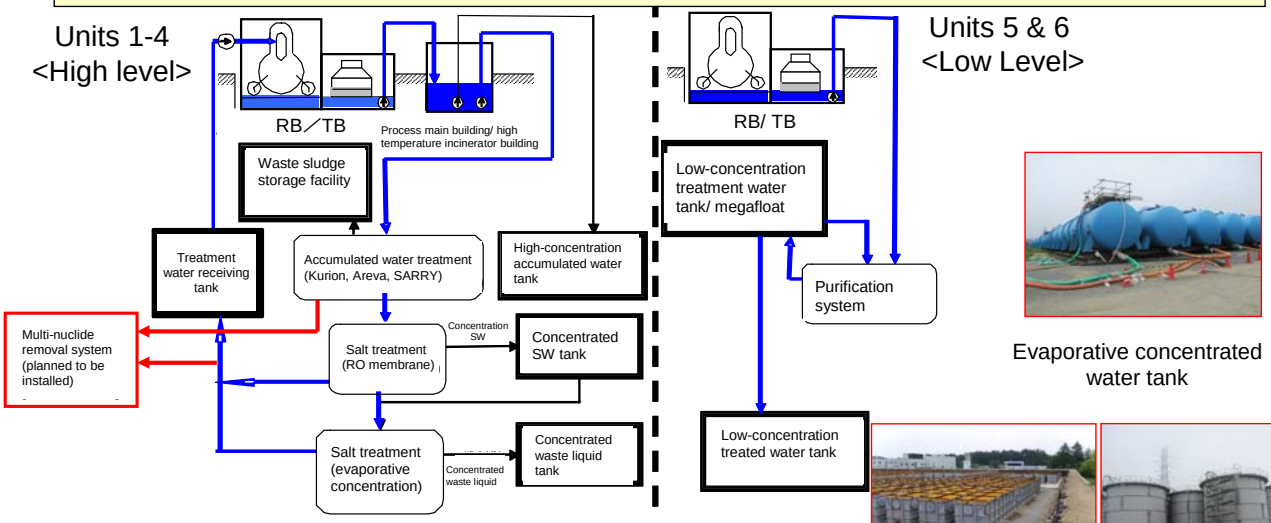
- Reliability improvement of Water Treatment Facility and Introduce Multi-nuclide Removal System (FY2012)
- Tanks with Total Capacity of 165 thousand tons are in operation.Additional 40-thousand be installed.
- Reduction of groundwater flow into the buildings



Evaporative concentrated water tank

Freshwater, RO concentrated water tanks

Preventing Dispersion of Radioactive Materials

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- An agent to prevent the dispersion of radioactive materials has been sprayed.
- Installed reactor building cover on Unit 1 (October 28, 2011).
- Reduced radiation level at the station site by removing rubble and storing/managing them according to radiation level.
- Installed PCV gas control system. (Unit1,2,3)
  - ✓Maintains PCV internal pressure at around atmospheric levels and manages the released amount of radioactive materials.

Installation of the reactor building cover on Unit 1

Removing rubble from Unit 4

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Mid-and-long Term Roadmap

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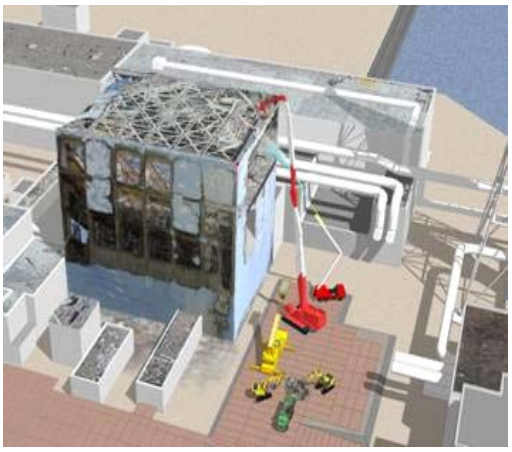
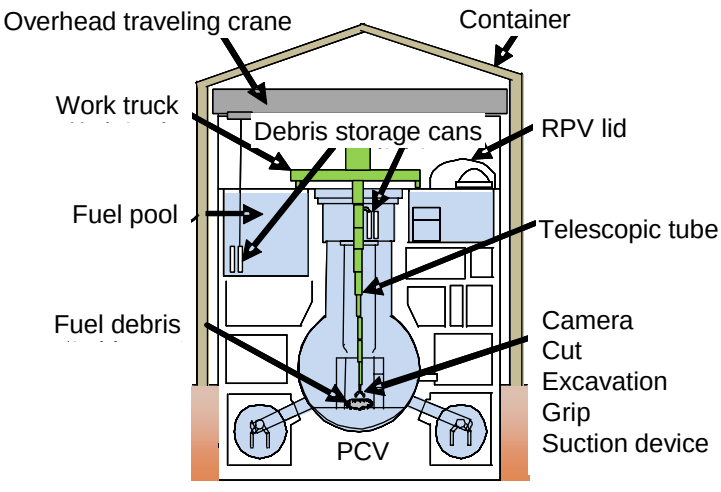
Present（Completion of Step 2）	Within 2 Years	Within 10 Years	After 30-40 Years
Step 1, 2	Phase 1	Phase 2	Phase 3
<Achieved Stable Conditions> -Condition equivalent to cold shutdown -Significant Suppression of Emissions	Period to the start of fuel removal from the spent fuel pool (Within 2 years)	Period to the start of fuel debris removal (Within 10 years)	Period to the end of decommissioning (After 30-40 years)



Removal of Rubble



Fuel debris taken out

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Target Timeline:
1) Reactor Cooling, Accumulated Water Processing

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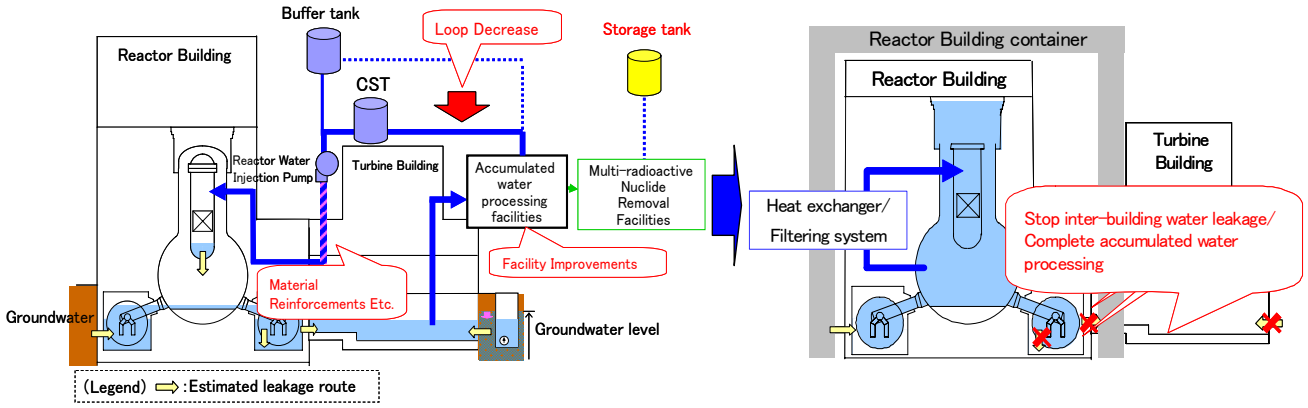
- In order to stably maintain “a condition equivalent to cold shutdown”, water injection cooling will be continued up to the completion of the fuel debris removal.
- By examining the reliability of the system, system improvements will be continuously implemented.
- During Phase 2, processing of accumulated water in the buildings will be finished. In order to achieve more stable cooling, scaling down of the circulation loop is being considered.



Target Timeline:
2) Plans to Mitigate Sea Water Contamination

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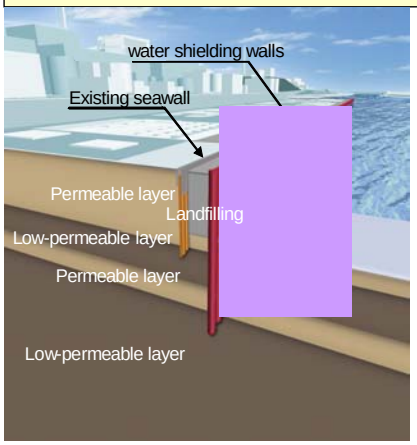
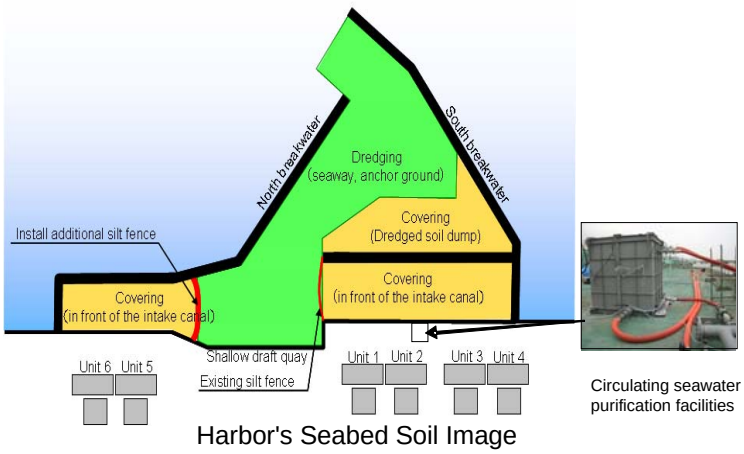
- Should underground water be contaminated, water shielding walls will be installed by mid FY2014 in order to prevent underground water from flowing into the ocean.
- Covering and solidifying seabed soil in front of the intake canal will prevent the diffusion of radioactive materials in the soil. By the end of FY2012, the continuous operation of the circulating seawater purification facilities will reduce radioactive materials in the seawater inside the site port to the level below the limit for the outside of environment surveillance areas as determined by a notification of the government. Sediments dredged in order to secure a navigable depth for large ships will be similarly covered.
- Afterwards, while maintaining the installed facilities, underground water and sea water etc. will be continuously monitored.



Water Shielding walls (Image)



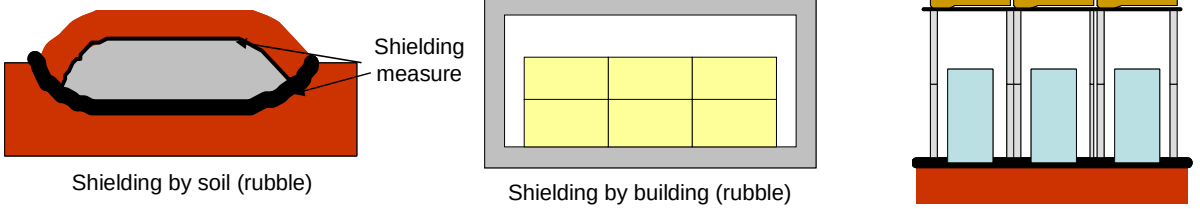
Harbor's Seabed Soil Image

Circulating seawater purification facilities

Target Timeline:

3) Radioactive Waste Management and Dose Reduction at the SiteBoundaries
4) Onsite Decontamination Plan

- Plan to reduce the effective radiation dose at the site boundaries to below 1 mSv / year by FY2012 as a target date, due to additional emissions from the whole site and radioactive waste stored on the site after the accident (secondary waste materials via water processing and rubble etc.).
- Plan to develop a facility renewal plan by the end of FY2014 that includes the lifetime assessment of the containers for secondary waste materials via water processing.
- Plan to continue ongoing land and sea environmental monitoring.
- In order to reduce exposure to the public and workers while improving the work environment, step-by-step decontamination measures will be implemented starting from the offices and working areas such as the Main Anti-Earthquake Building in conjunction with efforts to reduce radiation dosage outside the site.



Shielding by soil (rubble)

Shielding by building (rubble)

Shielding by sandbags etc.
(secondary waste materials
via water processing)

Shielding Measures
(example)

Lessons of the Response Policy to Prevent Core Damage

- **This accident occurred due to the simultaneous loss of multiple safety functions due to tsunami.**
- **Proposed safety improvement measures for existing NPPs based on lessons learned.**

Policy 1 : In addition to **measures against tsunami itself**, which was the direct cause of the accident, implement **exhaustive tsunami measures for equipment important** to core injection and cooling, considering accident response operations and plant behavior issues.

Policy 2: Implement **measures that flexibly secure functions with increased applicability and agility** to prevent core damage, presuming multiple equipment failure or functional loss like in this accident (caused by "extended simultaneous loss of all AC and DC power" and "extended loss of emergency seawater system heat removal function").

Policy 3: As additional measures, while placing first priority on preventing core damage, implement **measures that mitigate the impact of core damage if it does occur.**

Immediate Safety Measures at Kashiwazaki-Kariwa NPS

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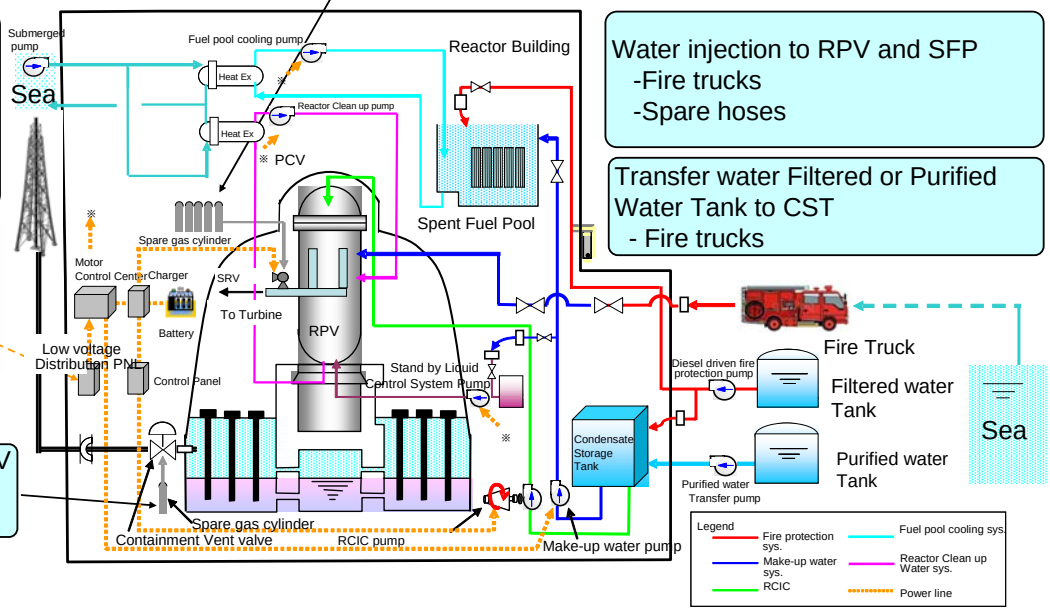
Spare pump for sea water pump
- Submerged pumps
- Spare hoses

To Depressurize RPV
-Spare gas cylinders

Emergency Power Supply Capability under Tsunami SBO
- High voltage power trucks
- Portable generators
- spare cables

Mobile power trucks

To Depressurize PCV
- Spare gas cylinders



Water injection to RPV and SFP
-Fire trucks
-Spare hoses

Transfer water Filtered or Purified Water Tank to CST
- Fire trucks

Revamped safety at TEPCO's 7-unit nuclear power station

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Emergency Response Training at Kashiwazaki Kariwa NPS

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Emergency Response HQ

On board Gas Turbine Generator (4500kVA)

Emergency Installation of the Electric Cables

Debris Removal

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Further Safety Measures at the Kashiwazaki-Kariwa NPS (1)

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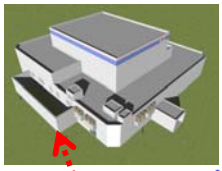
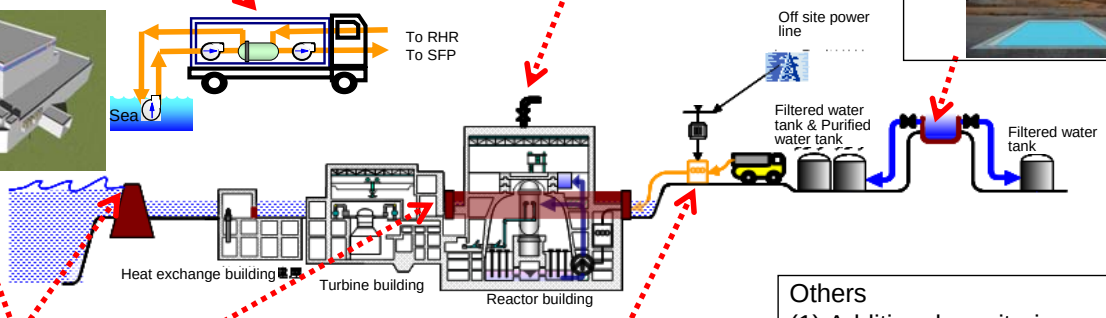
Enforcement of injection and heat removal
- Submerged pump
- Heat exchanger truck
- Spare hose

Prevention of accumulating Hydrogen
(1)Top vent on Reactor Building

Enforcement of injection and heat removal
(2)Reservoir on site.





Enforcement of protection for flooding
(1)Embankment
(2)Wall
(3)Water-tight doors in Reactor Building

Enforcement of power source
(1)GT-driven generator truck
(2)Emergency high voltage distribution panel
(3)Cable from emergency high voltage panel for RHR

Others
(1) Additional monitoring cars

(2) Additional warehouse for emergency materials on the hill

Further revamping safety at TEPCO's 7-unit nuclear power station.

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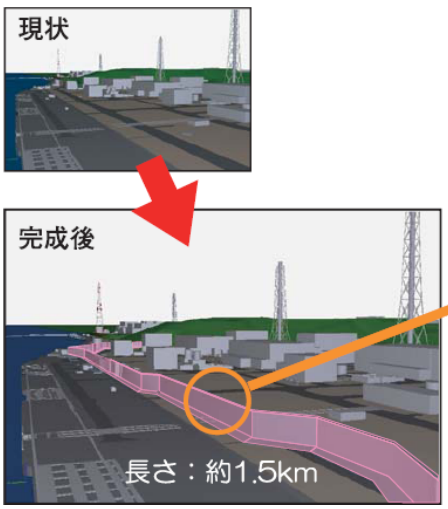
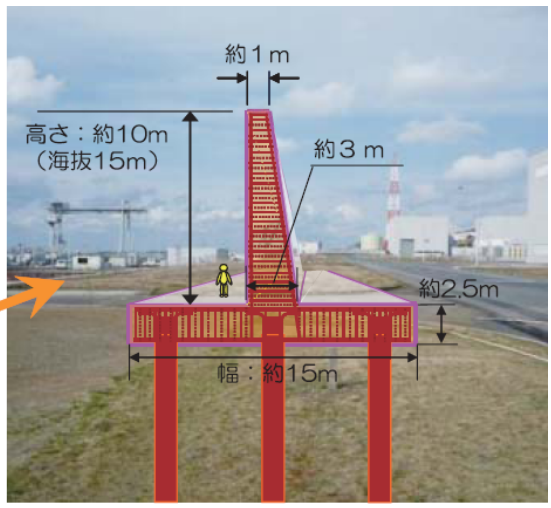
Further Safety Measures at the Kashiwazaki-Kariwa NPS (2)

30

Alternative Water Injection (8 fire engines)

On-board Generators (500-750kVA, 14 Generators in addition to 2 On-board Gas Turbine Generators of 4500kVA)





Water tight Doors

Construction of 15-meter Seawalls

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Monitoring Initiatives Toward Decontamination

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Soil Sampling

Ambient dose rate measurement

Basic data collection monitoring and measurement work

Regional monitoring and measurement

Ambient dose rate measurement with monitoring car

Decontamination Efforts

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- TEPCO developed decontamination plans and conducted measurements with personnel and monitoring car (approximately 500 man-days total, as of the end of March 2012)
- TEPCO provides support mainly for radiation management and work supervision to JAEA (Japan Atomic Energy Agency), who is commissioned with the Cabinet Office's Model Decontamination Project, to allow it to progress smoothly. (39 personnel)
- TEPCO followed the 36 personnel who were commissioned by the Ministry of Environment (MOE) as decontamination activity promoters, in giving assistance to monitoring, decontamination technologies, wastewater treatment and waste management during the decontamination of government buildings by the Self Defense Force.
- TEPCO assigned employees with radiation knowledge to the government's Expert Dispatch Program to respond to municipalities' questions and to develop specific decontamination plans.

Assisting Self Defense Force

Decontamination (in Ohkuma-machi)
(photo taken on November 4, 2011)

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For Stable Power Supply
–Emergency Restoration of the damaged Thermal Power Stations

Restoration of the damaged Thermal Power Stations		
Power Station	Capacity (MW)	Restoration
Kashima#1-#6	4400	Summer 2011
HItachinaka#1	1000	Summer 2011
HIrono#1-#5	3800	Summer 2011
Ohi#1-#3	1050	March 2011
Chiba#2-1	360	March 2011
Goi#4	265	March 2011
Yokohama#8-4	350	March 2011
Higashiougishima#1	1000	March 2011
Kashima Kyodo	1050	Summer 2011
Souma Kyodo	2000	Winter 2011
Joban Nakoso#7-#9	1050	Summer 2011
AboveTotal	16325	

Hirono Thermal Power Station

Hitachinaka Thermal Power Station

For Stable Power Supply
–Emergency Installation of the Generating Capacity

Emergency Installation Capacity		
Location	Capacity (MW)	Commissioning
Anegasaki	6	Summer 2011
Sodegaura	110	Summer 2011
Chiba	333x2	Summer 2011
Chiba	333x1	Summer 2012
Chiba c.c	500	Summer 2014
Ohi	210	Summer 2011
Kawasaki	130	Summer 2011
Yokosuka	330	Summer 2011
Hitachinaka	250	Summer 2011 Decommissioned 2012
Kashima	800	Summer 2012
Kashima c.c.	450	Summer 2014
Above Total	3786	
Source: TEPCO		

Sharing Knowledge

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TOKYO ELECTRIC POWER COMPANY