Information on Status of Nuclear Power Plants in Fukushima

Japan Atomic Industrial Forum, Inc.

Policy on information and compilation
This JAIF-compiled information chart represents the situation, phenomena, and operations in which JAIF estimates and guesses the reactors and related facilities are, based on the latest data and information directly and indirectly made available by the relevant organizations when JAIF's updating works done. Consequently, JAIF may make necessary changes to descriptions in the chart, once (1) new developments have occurred in the status of reactors and facilities and (2) JAIF has judged so needed after reexamining the prior information and judgments.
JAIF will do its best to keep tracks on the information on the nuclear power plants quickly and accurately.

Status of nuclear power plants in Fukushima as of 20:00, April 20th (Estimated by JAIF)

Power Station	Fukushima Dai-ichi Nuclear Power Station					
Unit	1	2	3	4	5	6
Electric / Thermal Power output (MW)	460 / 1380	784 / 2381	784 / 2381	784 / 2381	784 / 2381	1100 /3293
Type of Reactor	BWR-3	BWR-4	BWR-4	BWR-4	BWR-4	BWR-5
Operation Status at the earthquake occurred	In Service -> Shutdown	In Service -> Shutdown	In Service -> Shutdown	Outage	Outage	Outage
Fuel assemblies loaded in Core	400	548	548	No fuel rods	548	764
Core and Fuel Integrity (Loaded fuel assemblies)	Damaged (70%*1)	Damaged (30%*1)	Damaged (25%*1)	No fuel rods	Not Damaged	
Reactor Pressure Vessel structural integrity	Unknown	Unknown	Unknown	Not Damaged	Not Damaged	
Containment Vessel structural integrity	Not Damaged (estimation)	Damage and Leakage Suspected	Not damaged (estimation)	Not Damaged	Not Damaged	
Core cooling requiring AC power 1 (Large volumetric freshwater injection)	Not Functional	Not Functional	Not Functional	Not necessary	Functional	
Core cooling requiring AC power 2 (Cooling through Heat Exchangers)	Not Functional	Not Functional	Not Functional	Not necessary	Functioning (in cold shutdown)	
Building Integrity	Severely Damaged (Hydrogen Explosion)	Slightly Damaged	Severely Damaged (Hydrogen Explosion)	Severely Damaged (Hydrogen Explosion)	Open a vent hole on the rooftop for avoiding hydrogen explosion	
Water Level of the Rector Pressure Vessel	Fuel exposed partially or fully	Fuel exposed partially or fully	Fuel exposed partially or fully	Safe	Safe	
Pressure / Temperature of the Reactor Pressure Vessel	Gradually increasing / Decreased a little after increasing over 400℃ on Mar. 24th	Unknown / Stable	Unknown	Safe	Safe	
Containment Vessel Pressure	Decreased a little after increasing up to 0.4Mpa on Mar. 24th	Stable	Stable	Safe	Safe	
Water injection to core (Accident Management)	Continuing (Switch from seawater to freshwater)	Continuing (Switch from seawater to freshwater)	Continuing (Switch from seawater to freshwater)	Not necessary	Not necessary	
Water injection to Containment Vessel (AM)	(To be confirmed)	to be decided (Seawater)	(To be confirmed)	Not necessary	Not necessary	
Containment Venting (AM)	Temporally stopped	Temporally stopped	Temporally stopped	Not necessary	Not necessary	
Fuel assemblies stored in Spent Fuel Pool	292	587	514	1331	946	876
Fuel Integrity in the spent fuel pool	Unknown	Unknown	Damage Suspected	some of the spent fuel may have been damaged*3	Not Damaged	
Cooling of the spent fuel pool	Water spray started (freshwater)	Continued water injection (Switch from seawater to freshwater)	Continued water spray and injection (Switch from seawater to freshwater)	Continued water spray and injection (Switch from seawater to freshwater) Hydrogen from the pool exploded on Mar. 15th	Pool cooling capability was recovered	
Main Control Room Habitability & Operability	Poor due to loss of AC power (Lighting working in the control room at Unit 1 and 2.)		Poor due to loss of AC power (Lighting working in the control room at Unit 3 and 4.)		Not damaged (estimate)	
Environmental effect	●Status in Fukushima Dai-ichi NPS site Radiation level: 480μSv/h at the south side of the office building, 60μSv/h at the Main gate, 24μSv/h at the West gate, as of 15:00, Apr. 20th Small amount of plutonium was detected from the soil sampled at Fukushima Daiichi NPS site.(3/21-4/4). Radioactive materials were detected from underground water sampled near the turbine buildings. (3/30). The concentration of the radioactive materials has increased and the monitoring of the underground water is to be expanded. (4/16-) Radioactive materials exceeding the regulatory limit have been detected from seawater sample collected in the sea surrounding the Fukushima Dai-ichi NPS since Mar. 21st. I-131detected at near the discharge outlet is 1600 times as much as legal limit.(4/14) TEPCO and MEXT has expanded the monitoring for the surrounding sea area since Apr 4th. ●Influence to the people's life Radioactive material was detected from milk and agricultural products from Fukushima and neighboring prefectures. The government issued order to limit shipment (3/21-) and intake (3/23-) for some products. Radioactive iodine, exceeding the provisional legal limit, was detected from tap water sampled in some prefectures. Small fish(sand lances) caught in the sea near Fukushima have been found to contain radioactive cesium and iodine above the legal limit(4/5～). The government ordered to suspend shipment and warned not to eat them(4/20-). Small amount of strontium was detected from some samples of soil and plants taken in the area that is 20-80 km far from the power station. On Apr. 17th, TEPCO announced that that it plans tol expand the monitoring of the evacuation area and then decontaminate the houses and soils in the area to reduce the level of radioactive materials within about 3 to 6 months.					
Evacuation	<1> Shall be evacuated for within 3km from NPS, Shall stay indoors for within 10km from NPS (issued at 21:23, Mar. 11th) <2> Shall be evacuated for within 10km from NPS (issued at 05:44, Mar. 12th) <3> Shall be evacuated for within 20km from NPS (issued at 18:25, Mar. 12th) <4> Shall stay indoors (issued at 11:00, Mar. 15th), Should consider leaving (issued at 11:30, Mar. 25th) for from 20km to 30km from NPS <5>The 20km evacuation zone around the Fukushima Daiichi NPS is to be expanded so as to include the area, where annual radiation exposure is expected to be above 20mSv. People in the expanded zone are ordered to evacuate within a month or so. People living in the 20 to 30km and other than the expanded evacuation area mentioned above, are asked to get prepared for staying indoors or evacuation in an emergency (issued on Apr. 11th).					
INES (estimated by NISA)	Level 7*2 ※Cumulative amount of radioactivity from Fukushima Diichi NPS has reached the level to be classified as level 7. Total amount of radioactive materials released to the environment in this accident is one tenth as much as one in the Chernobyl accident so far.		Level 3 *2		–	–
Remarks	●Progress of the work to recover injection function High radiation circumstance hampering the work to restore originally installed pumps for injection at unit-1,2 and 3. Efforts have been made to remove radioactive water in the basement of the buildings of Unit 1through 3 to improve this situation. Transfer of highly radioactively contaminated water from Unit 2, where about 25,000 tons of such water has accumulated on the basement of its turbine building and in the concrete tunnel outside the building, to the waste processing facility began on Apr. 19th. It is estimated to take 26 days to transfer about 10,000 tons of the water. Distribution switchboards for water injection pumps of Unit 1through 3 reactors were moved to heights to avoid tsunami. On Apr. 17th, TEPCO announced that that it plans to fill the containment vessels of Unit 1 and 3 with water up to the levels of covering the fuels in the reactors while considering fixing the damaged containment vessel of Unit 2. It will also install heat exchangers to remove the heat from the reactors and lead them into cold shutdown within about 3 to 6 months. ●Function of containing radioactive material It is presumed that radioactive material inside the reactor vessel may leaked outside at Unit 1, 2 and Unit 3, based on radioactive material found outside. NISA announced that the reactor pressure vessel of Unit 2 and 3 may have lost air tightness because of low pressure inside the pressure vessel. NISA told that it is unlikely that these are cracks or holes in the reactor pressure vessels at the same occasion. Nitrogen gas injection into the Unit 1containment vessel has been continued to reduce the possibility of hydrogen explosion since Apr. 6th. The pressure of the vessel has hardly risen for the past a few days and leakage of the vessel is suspected. While the originally planned amount of nitrogen has been injected by Apr. 16th, injection will be continued for a while to maintain the concentration of nitrogen in the vessel. On Apr. 17th, TEPCO announced that it plans to install facilities and tanks to process and store the highly radioactive water accumulated in the buildings and tunnels. It will also install huge covers with special filters to contain the reactor buildings so as to control the release of radioactive materials to the environment within about 3 to 6 months. ●Cooling the spent fuel pool Steam like substance rose intermittently from the reactor building at Unit 1, 2, 3 and 4 has been observed. Injecting and/or spraying water to the spent fuel pool has been conducted. ●Prevention of the proliferation of contaminated dust: Testing the spraying synthetic resin to contain contaminated dust began on Apr. 1st. Full operation is planned to start on Apr. 26th.					

[Source]
Government Nuclear Emergency Response Headquarters:
News Release (-4/20 17:00), Press conference
NISA: News Release (-4/20 15:00), Press conference
TEPCO: Press Release (-4/20 12:00), Press Conference

[Abbreviations]
MEXT: Ministry of Education, Culture, Sports, Science and Technology
INES: International Nuclear Event Scale
NISA: Nuclear and Industrial Safety Agency
TEPCO: Tokyo Electric Power Company, Inc.
NSC: Nuclear Safety Commission of Japan

*1 TEPCO's estimation based on the radiation level in the CV
*2 Correction: Rating was raised from 5 to 7 for the accident of Unit 1 through 3
*3 It is presumed that some of the spent fuel may have been damaged based on radioactive substance detected from the water sample taken from the pool of Unit 4.

[Significance judged by JAIF]
Low
High
Severe (Need immediate action)

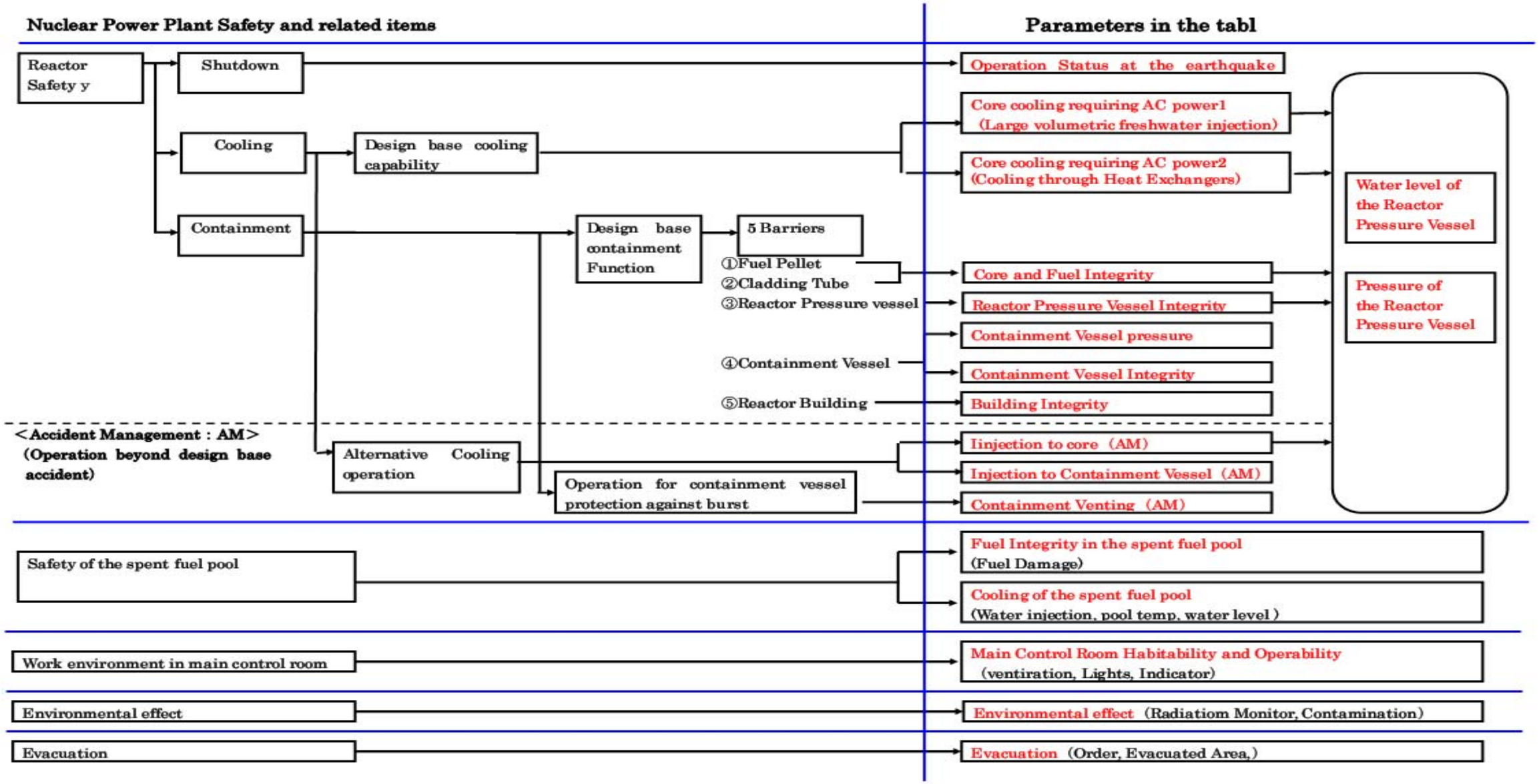
Power Station	Fukushima Dai-ni Nuclear Power Station			
Unit	1	2	3	4
Electric / Thermal Power output (MW)	1100 / 3293			
Type of Reactor	BWR-5	BWR-5	BWR-5	BWR-5
Operation Status at the earthquake occurred	In Service -> Automatic Shutdown			
Status	All the units are in cold shutdown.			
INES (estimated by NISA)	Level 3	Level 3	—	Level 3
Remarks	Unit-1, 2, 3 & 4, which were in full operation when the earthquake occurred, all shutdown automatically. External power supply was available after the quake. While injecting water into the reactor pressure vessel using make-up water system, TEPCO recovered the core cooling function and made the unit into cold shutdown state one by one. No parameter has shown abnormality after the earthquake occurred off an shore of Miyagi prefecture at 23:32, Apr. 7th. Latest Monitor Indication: 2.1 μ Sv/h at 15:00, Apr. 19th at NPS border Evacuation Area: 10km from NPS			

Power Station	Onagawa Nuclear Power Station		
Unit	1	2	3
Operation Status at the earthquake occurred	In Service -> Automatic Shutdown		
Status	All the units are in cold shutdown.		
Remarks	3 out of 4 external power lines in service with another line under construction broke down after an earthquake occurred off the shore of Miyagi prefecture at 23:32, Apr. 7th. All 5 external power lines have become available by Apr. 10th. Monitoring posts' readings have shown no abnormality. All SFP cooling systems had been restored after shutting down due to the earthquake.		

Power Station	Tokai Dai-ni
Operation Status at the earthquake occurred	In Service -> Automatic Shutdown
Status	In cold shutdown.
Remarks	No abnormality has been found after an earthquake occurred off the shore of Miyagi prefecture at 23:32, Apr. 7th.

Parameters in the Table

JAIF picks up these parameters to evaluate safety condition of the nuclear plants during this accident from the view point of the principles of nuclear power plant safety, which are "Shutdown", "Cooling" and "Containment". Then we create the chart. The following diagram is to show the correspondence relation of these parameters in the table to nuclear power plant safety.



Accidents of Fukushima Daiichi Nuclear Power Stations

(as of 13:00, April 20th)

1. Latest Major event and response

Apr. 17th

09:00-11:15 Seven sandbags containing absorbent named zeoliteon were installed near the seawater screens between Unit 1 and 2 and between Unit 2 and 3.

11:30-17:30 Investigation of the Inside of the Unit 1 and 3 R/B was conducted using a remote-controlled robot.

TEPCO announced a roadmap towards restoration from the accident at Fukushima Daiichi NPS.

Apr. 19th

10:08 Transfer of highly radioactively contaminated water accumulated in the Unit 2 turbine building to the waste processing facility began.

2. Chronology of Nuclear Power Stations

(1) Fukushima Dai-ichi NPS

	Unit 1	Unit 2	Unit 3	Unit 4	Unit-5 and 6
Major Incidents and Actions **The Act on Special Measures Concerning Nuclear Emergency Preparedness*	11th 15:42 Report IAW Article 10* (Loss of power)	11th 15:42 Report IAW Article 10* (Loss of power)	11th 15:42 Report IAW Article 10* (Loss of power)	14th 04:08 Water temperature in Spent Fuel Storage Pool increased at 84℃	19th 05:00 Cooling SFP with RHR-pump started at Unit 5 19th 22:14 Cooling SFP with RHR-pump started at Unit 6
	11th 16:36 Event falling under Article 15* occurred (Incapability of water injection by core cooling function)	11th 16:36 Event falling under Article 15* occurred (Incapability of water injection by core cooling function)	12th 20:41 Start venting	15th 09:38 Fire occurred on 3rd floor (extinguished spontaneously)	20th 14:30 Cold shutdown achieved at Unit 5. 20th 19:27 Cold shutdown achieved at Unit 6.
	12th 00:49 Event falling under Article 15* occurred (Abnormal rise of CV pressure)	13th 11:00 Start venting	13th 05:10 Event falling under Article 15* occurred (Loss of reactor cooling functions)	16th 05:45 Fire occurred (extinguished spontaneously)	22nd 19:41 All power source was switched to external AC power at Unit 5 and 6.
	12th 14:30 Start venting	14th 13:25 Event falling under Article 15* occurred (Loss of reactor cooling functions)	13th 08:41 Start venting	Since 20th, operation of spraying water to the spent fuel pool continues.	Apr. 1st 13:40 Start transferring pooled water in the Unit 6 radioactive waste process facility to the Unit 5 condenser.
	12th 15:36 Hydrogen explosion	14th 16:34 Seawater injection to RPV	13th 13:12 Seawater injection to RPV	29th 11:50 lights in the main control room becomes available	
	12th 20:20 Seawater injection to RPV	14th 22:50 Report IAW Article 15* (Abnormal rise of CV pressure)	14th 05:20 Start venting		
	22nd 11:20 RPV temperature increased	15th 00:02 Start venting	14th 07:44 Event falling under Article 15* occurred (Abnormal rise of CV pressure)		
	22nd 02:33 Seawater injection through feed water line started in addition to fire extinguish line	15th 06:10 Sound of explosion, Suppression Pool damage suspected	14th 11:01 Hydrogen explosion		
	24th 11:30 lights in the main control room becomes available	15th 08:25 White smoke reeked	15th 10:22 Radiation dose 400mSv/h		
	25th 15:37 Freshwater injection to the reactor started.	20th 15:05 operation of spraying water to the spent fuel pool started.	16th 08:34, 10:00 White smoke reeked		
	27th 08:30 Continuing to transfer the water in the basement of the turbine building	26th 10:10 Freshwater injection to the reactor started.	Since 17th, operation of spraying water to the spent fuel pool continues.		
	31st 09:20-11:25 Work to remove the water in the trench	26th 16:46 lights in the main control room becomes available	21st 15:55 Slightly gray smoke erupted (18:02 settled)		
	31st 12:00 Start to transfer the water in the CST to the surge tank (- 15:27, Apr. 2)	29th 16:45 Start to transfer the water in the CST to the surge tank	22nd 22:46 lights in the main control room becomes available		
	31st 13:03 Start water injection to SFP	Apr. 2nd 16:25 Start injecting concrete to stop water leakage from the pit near the intake	25th 18:02 Freshwater injection to the reactor started.		
	Apr. 7th 01:31 Injection of Nitrogen gas started after opening all valves through the line.	2nd 17:10 Start transferring water in the conden4er to the CST	28th 17:40 Start to transfer the water in the CST to the surge tank		
	Apr. 10th 09:30 Transfer of water from the main condenser to the CST completed.	Apr. 5th 15:07 Regarding leakage from the pit that is closed to discharge outlet of unit-2, hardening agent was injected to hole dug surrounding the pit. (Apr. 6 05:38 It was confirmed that water flow stopped	Apr. 13 13:50 Installation of silt fences in front of the Unit 3 and 4 seawater screen completed		
	Apr 17 16:00 Start investigation of the inside of R/B using a remote-controlled robot.		Apr 17 11:30 Start investigation of the inside of R/B using a remote-controlled robot.		
		Apr. 9th 13:10 Transfer of water from the main condenser to the CST completed.			
		Apr. 13th 17:04 Transfer of highly radioactively contaminated wafter accumulated in the trench outside the turbine building to the condenser completed			
		Apr. 15th 14:15 Installation of steel plate in front of Unit 2 seawater screen completed			
	Apr. 3rd 12:18 Switch power supply for water injection pumps to the RPV from power supply vehicles to originally equipped power source				
	Apr. 14 12:20 Installation of silt fences in front of the Unit 1and 2 seawater screen and intake completed				
Major Data *1	Reactor Water level (Apr. 20 12:00) (A) -1700mm, (B) -1700mm	Reactor Water level (Apr. 20 12:00) (A) -1500mm, (B) -2100mm	Reactor Water level (Apr. 20 12:00) (A) -1850mm, (B) -2250mm	Thermography (Apr. 18 07:30) SFP: 20℃	Water temperature of SFP Unit 5 42.4℃ (Apr. 20 13:00) Unit 6 30.3℃ (Apr. 20 13:00)
	Reactor pressure (Apr. 20 12:00) (A) 0.420MPaG, (B) 1.078MPaG*2	Reactor pressure (Apr. 20 12:00) (A) -0.023MPaG*2, (B) -0.029MPaG*2	Reactor pressure (Apr. 20 12:00) (A) -0.043MPaG*2, (B) -0.089MPaG*2		
	CV pressure (Apr. 20 12:00) 0.160MPaabs	CV pressure (Apr. 20 12:00) 0.080MPaabs	CV pressure (Apr. 20 12:00) 0.1045MPaabs		
	RPV temperature (Apr. 20 12:00) 154.1℃*2 at feed water line nozzle	RPV temperature (Apr. 20 12:00) 134.7℃ at feed water line nozzle	RPV temperature (Apr. 20 12:00) 100.2℃*2 at feed water line nozzle		
		Water temperature in SFP (Apr. 20 12:00) 71.0℃			
	Thermography (Apr. 18 07:30) CV: 21℃, SFP: 15℃	Thermography (Apr. 18 07:30) Top of R/B: 20℃	Thermography (Apr. 18 07:30) CV: 31℃, SFP: 55℃		

(2) Fukushima Dai-ni NPPs

All units are cold shutdown (Unit-1, 2, 4 have been recovered from a event falling under Article 15*)

3. State of Emergency Declaration

11th 19:03 State of nuclear emergency was declared (Fukushima Dai-ni NPS)

12th 07:45 State of nuclear emergency was declared (Fukushima Dai-ichi NPS)

4. Evacuation Order

11th 21:23 PM direction: for the residents within 3km radius from Fukushima I to evacuate, within 10km radius from Fukushima I to stay in-house

12th 05:44 PM direction: for the residents within 10km radius from Fukushima I to evacuate

12th 17:39 PM direction: for the residents within 10km radius from Fukushima II to evacuate

12th 18:25 PM direction: for the residents within 20km radius from Fukushima I to evacuate

15th 11:06 PM direction: for the residents within 20-30km radius from Fukushima I to stay in-house

25th Governmental advise: for the residents within 20-30 km radius from Fukushima I to voluntarily evacuate

Abbreviations:
SFP: Spent Fuel Storage Pool
EDG: Emergency Diesel Generator
RPV: Reactor Pressure Vessel
R/B: Reactor Building
RHR: Residual Heat Removal system
CST: Condensate water Storage Tank
T/B: Turbine Building

*1 Trend data of primary parameters are available at Japan Nuclear Technology Institute's Home Page; "http://www.gengikyo.jp/english/shokai/special_4.html".
*2 Data trend is continuously monitored.

Status of the Nuclear Power Plants after the Earthquake

The accident that brings environmental impact is going on at several units in Fukushima Daiichi nuclear power Station after the earthquake occured on March 11th. Other nuclear power plants in Japan are in normal operation or safely shutdown.