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 12:00, May 11th (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 (55%*1)	Damaged (35%*1)	Damaged (30%*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 / Gradually increasing	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)	Feed water to fill up the CV (started 4/27)	Feed water to fill up the CV (planned)	Feed water to fill up the CV (planned)	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 continues (freshwater)	water injection continues (Switch from seawater to freshwater)	Water spray and injection continues (Switch from seawater to freshwater)	Water spray and injection continues (Switch from seawater to freshwater), Hydrogen from the pool exploded (3/15)	Pool cooling capability was recovered	
Main Control Room Habitability & Operability	Poor due to loss of AC power (Lighting and parmaeter monitoring restored in the control room at Unit 1 and 3 on Mar. 24th, at Unit 2 on Mar. 26th, at Unit 4 on Mar. 29th)				Not damaged (estimate)	
Environmental effect	●Status in Fukushima Dai-ichi NPS site Radiation level: 404 μ Sv/h at the south side of the office building, 43 μ Sv/h at the Main gate, 16 μ Sv/h at the West gate, as of 09:00, May 11th. Small amounts of Radioactive nuclides(I, Cs, Pu(3/28), Am and Cm(4/27), Sr(sampled on 4/18, published on 5/8)) has been detected in soil sampled at the Fukushima site. Radioactive materials continues to be detected in samples corrected from underground water and sea water at or near the site. Environmental monitoring has been enhanced. Radioactive Iodine and cesium have been detected in the seabed samples taken 15-20 km far from the plant from 15-20m deep. Level of radiation is 100 to 1,000 times above normal. (5/4) ●Influence to the people's life Radioactive material was detected from milk, agricultural products and seafood from Fukushima and neighboring prefectures. The government issued order to limit shipment and intake of some products. Radioactive iodine, exceeding the provisional legal limit for drinking water, was detected from tap water sampled in some prefectures. Radioactive cesium was detected in the sludge from a sewage treatment plant 50 km far from the power station. Small amount of strontium was detected in some samples of soil and plants corrected in the area that is 20-80 km far from the power station.					
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 (announced on Apr. 11th and issued on Apr. 22nd).					
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 restore cooling function TEPCO announced its plan to bring the damaged reactors to a stable condition known as a "cold shutdown" in about six to nine months, a situation in which water temperatures inside the reactors have been stably brought below 100 C.(4/17) High radiation circumstance hampering the work to restore reactor cooling function at unit-1,2 and 3. Operation to discharge radioactive water in the basement of the buildings and concrete tunnels outside the buildings of all Unit 1, 2, 3, started with unit 2 on April 19 and counties. Blocking the concrete tunnel was started at Unit 2.(5/1-) Ventilators were installed at Unit 1(5/5), to clean the highly radioactive air inside the reactor building for improving working environment. The doors of the building were opened (5/8-) and calibration of reactor water level monitors was started after surveying the radiation dose in the building (5/9-). Emergency power generators were moved to higher ground in order to prevent the reactors' cooling systems from failing in case a major tsunami hits the plant again. External power source becomes more reliable after connecting 3 power lines with each other, which are for Unit 1/2, for Unit 3/ 4 and for Unit 5/6. The damaged containment vessel of unit 2 is need to be repaired before the work to restore reactor cooling function. TEPCO developed the plan to cool the reactor through filling the containment vessel with water up to the top of fuel level. NISA accepted TEPCO`s safety evaluation for this plan for unit 1 such as impact of increased dead weight of water.(5/5) The operation of pumping more water into No1 reactor in line with this plan continues. ●Function of containing radioactive material It is presumed that radioactive material inside the reactor vessel may leaked outside. NISA estimated that the reactor pressure vessel of Unit 2 and 3 may have lost air tightness. Nitrogen gas injection into the Unit 1containment vessel to prevent hydrogen explosion started on April 6th and continues. ●Cooling the spent fuel pool (SFP) Injecting and/or spraying water to the SFP continues for the purpose cooling and make up water evaporated. Corrosion inhibitor, Hydrazine (H2NNH2), has been injected into the SFP (5/7-). The walls of the reactor building supporting the pool were severely damaged by an explosion on March 15th at unit-4. Work for structural reinforcement to support the SFP is necessary. ●Prevention of the proliferation of radioactively contaminated substance: TEPCO announced the plans to prevent radioactively contaminated water, dust and soil and radioactive material itself existing on site from spreading on Apr 17. Full operation of spraying synthetic resin to contain contaminated dust started on Apr. 26th and continues. ●Worker's exposure dose: 21 workers has been exposed to between 100 and 250mSv as of 4/30. *Emergency exposure dose limit has been set to 250mSv.					

[Source]
Government Nuclear Emergency Response Headquarters:
News Release (-5/10 17:00), Press conference
NISA: News Release (-5/10 12:00), Press conference
TEPCO: Press Release (-5/11 09:00), 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 revised on April 27
*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)

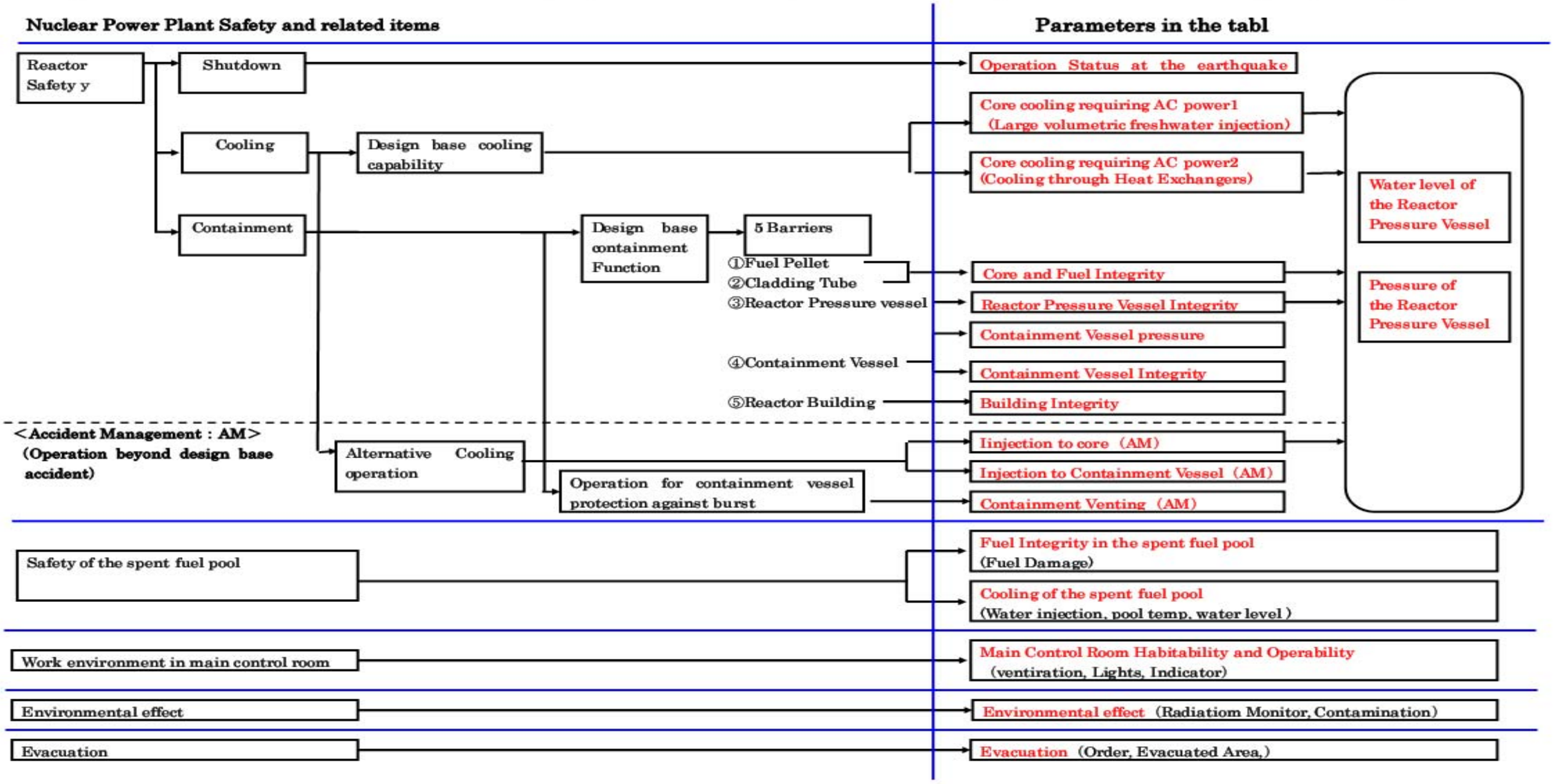
Power Station	Fukushima Dai-ni Nuclear Power Station			
Unit	1	2	3	4
Electric / Thermal Power output (MW)	1100 / 3293			
Type of Reactor	BWR-5	BWR-5	BWR-5	BWR-5
Operation Status at the earthquake occurred	In Service -> Automatic Shutdown			
Status	All the units are in cold shutdown.			
INES (estimated 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: 1.7 μ Sv/h at 9:00, May 11th at NPS border Evacuation Area: 3km from NPS(3/12 7:45), 10km from NPS(3/12 17:39), 8km from NPS(4/21)			

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 17:00, May 10th

1. Latest Major event and response

May 8th
09:00-16:00 Operation to remove rubble by remotely controlled heavy machines conducted today.
10:30-14:00 Operation of spraying synthetic resin to prevent contaminated dust and soil from spreading was conducted.
12:10-14:10 Operation of injecting water to the Unit 3 SFP was conducted
20:08 Air ducts penetrating the access doors of Unit 1 R/B were cut off, making the doors partly open.
May 9th
04:17 The Access doors of Unit 1 R/B were opened.
09:00-16:00 Operation to remove rubble by remotely controlled heavy machines conducted today.
12:14-15:00 Operation of injecting water to the Unit 3 SFP was conducted
16:05-19:05 Operation of spraying water to the Unit 4 SFP was conducted
May 10th
13:09-14:45 Operation of injecting water to the Unit 3 SFP was conducted
Brief home visit of evacuees has been started.

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
	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)	19th 22:14 Cooling SFP with RHR-pump started 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)	20th 14:30 Cold shutdown achieved at Unit 5. 20th 19:27 Cold shutdown achieved at Unit 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.	22nd 19:41 All power source was switched to external AC power at Unit 5 and 6.
	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		Apr. 1st 13:40 Start transferring pooled water in the Unit 6 radioactive waste process facility to the Unit 5 condenser.
	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		May2 10:00 The operation of transferring water accumulated in Turbine bldg of unit-6 to the makeshift tank started.
	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. 9th 13:10 Transfer of water from the main condenser to the CST completed.	Apr 17 11:30 Start investigation of the inside of R/B using a remote-controlled robot.		
	Apr. 29 11:36 The inside of the building was inspected. It was confirmed that there is no water significant leakage from the CV.	Apr. 13th 17:04 Transfer of highly radioactively contaminated wafter accumulated in the trench outside the turbine building to the condenser completed			
	May 2 12:58 Water feeding was temporally switched from to the reactor injection pump to the fire pump to install alarm device to the reactor injection pump.	Apr. 15th 14:15 Installation of steel plate in front of Unit 2 seawater screen completed			
	May 5 11:32-16:36 Ventilators to clean the highly radioactive air inside the reactor building were installed and started.	Apr 18 13:42 Start investigation of the inside of R/B using a remote-controlled robot.			
		Apr. 19 10:08 Start transferring highly radioactive water accumulated in the turbine building and the concrete tunnel to the waste processing facility			
		Apr. 30 14:05 Start transferring highly radioactive water accumulated in the vertical part of the concrete tunnel outside the turbine BLDG to the waste processing			
		May 1 13:35 The work to block the vertical concrete tunnel outside the turbine bldg started.			
		May 2 12:58 Water feeding was temporally switched from to the reactor injection pump to the fire pump to install alarm device to the reactor injection pump.			
	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 (May 10 11:00) (A) (under calibration), (B) -1650mm	Reactor Water level (May 10 11:00) (A) -1500mm, (B) -2100mm	Reactor Water level (May 10 11:00) (A) -1800mm, (B) -2100mm	SFP water temperature measured with a concrete pump vehicle Apr. 12 : about 90℃ 22 before spray: about 91℃ 23 before spray: about 83℃ 23 after spray : about 66℃ 24 before spray: about 86℃ 24 after spray : about 81℃	Water temperature of SFP Unit 5 30.0℃ (May 10 13:00) Unit 6 28.0℃ (May 10 06:30)
	Reactor pressure (May 10 11:00) (A) 0.463MPaG, (B) 1.273MPaG*2	Reactor pressure (May 10 11:00) (A) -0.020MPaG*2, (B) -0.016MPaG*2	Reactor pressure (May 10 11:00) (A) -0.079MPaG*2, (B) -0.083MPaG*2		
	CV pressure (May 10 11:00) 0.120MPaabs	CV pressure (May 10 11:00) 0.060MPaabs	CV pressure (May 10 11:00) 0.1006MPaabs		
	RPV temperature (May 10 11:00) 114.7℃*2 at feed water line nozzle	RPV temperature (May 10 11:00) 115.3℃ at feed water line nozzle Water temperature in SFP (May 10 11:00) 48.0℃	RPV temperature (May 10 11:00) 214.5℃*2 at feed water line nozzle		
	Thermography (Apr. 26 07:30) CV: 25℃, SFP: 23℃	Thermography (Apr. 26 07:30) Top of R/B: 24℃	Thermography (Apr. 26 07:30) CV: 26℃, SFP: 56℃		

(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.