State of Immediate Response after Disaster Struck at Fukushima Daiichi Power Station

This document is compilation of facts as they are known at the present time based on a variety of report and eye witness accounts. If and when new facts come to light hereafter as the investigation continues, they will be disclosed at that time.

◆ March 11 at 2:46 p.m. - Details of actions taken from the moment of the "Tohoku-Chihou-Taiheiyo-Oki Earthquake" until the "arrival of the first tsunami wave at 3:27 p.m."

[Ascertaining of safety and evacuation]

- Personnel in the main office building evacuated to the designated parking lot, and after a head-count of personnel, the Emergency Disaster Countermeasures Team took refuge in the seismic damping isolation bunker and began implementing countermeasures. As a disaster drill had been carried out as recently as only about one week earlier, all personnel were familiar with the evacuation routes.

[Normal SCRAM Response Operation]

<Units 1 & 2 Main Control Room>

- The operators waited for the shaking to stop and then began normal SCRAM response operations. The Shift Supervisor confirmed that the SCRAM was in effect, and then took command from a position between the Unit 1 and Unit 2 panels. An operator was stationed in front of each of the control panels following the instructions of the senior reactor operator, and the conditions were monitored and operations performed. The senior reactor operator reported the plant conditions and operations to the Shift Supervisor.
- 2:52 p.m. - The Unit 1 Isolation Condenser (abbreviated "IC") was confirmed to have started. The reactor water level was normal, so the High Pressure Coolant Injection system (HPCI) would kick in when reactor water level fell, and reactor pressure was regulated via the IC.
- Approximately 3:03 p.m. - Rate of Unit 1 pressure reduction increased and it was determined that compliance with technical specifications of reactor coolant temperature drop rate of 55℃ per hour was not possible, and the IC return-pipe isolation valves (MO-3A, 3B) were closed. Other valves remained open and in normal standby state. Thereafter, it was determined that one IC system was sufficient to regulate the reactor pressure to around 6~7MPa and the A system was used for regulating, and regulation of reactor pressure via opening and closing the return-pipe isolation valve (MO-3A) was commenced.

・ Although the Unit 2 Reactor Core Isolation Cooling system (RCIC) was started up manually, a system trip was confirmed to have occurred due to high reactor water level. (Later, RCIC was manually restarted.)

<Units 3 & 4 Main Control Room>

・ Inside the Main Control Room, operators waited for the seismic shaking to stop as a smokescreen of white dust hung in the air, and then began normal SCRAM response operation. The Shift Supervisor received a report that SCRAM was in effect. External power was lost, and the emergency Diesel Generators (abbreviated "DG") started up, and the emergency bus was confirmed to be electrified.
・ Unit 3 RCIC was started manually, and system trip due to high reactor water level was confirmed.
・ After the earthquake, a head-count of the shift personnel was conducted and paging notification of the earthquake and tsunami was carried out.

<Units 5 & 6 Main Control Room>

・ The Shift Supervisor guarded his own safety while monitoring the panel from his own position and waited for the shaking to stop. Other operators took cover while watching the instrument panel and racks. When the shaking stopped, the room reverberated from nearly all alarms sounding at once, and then began checking each of the alarms.
・ Paging and ITV were inoperable, so evacuation orders were conveyed to the field via cell phone. Shift workers assembled in the waiting room, then returned to the Main Control Room.

◆ **March 11, 3:42 p.m. - Details of actions taken after total loss of AC power was determined and announced**

[Situation inside the Units 1 & 2 Main Control Room]

・ With the complete loss of all AC power, all lights, indicator lamps, and even alarm sounds gradually faded out, only the emergency lighting remained on the Unit 1 side and the Unit 2 side was in total darkness. Under the direction of the Shift Supervisor, personnel checked to see which equipment was still functional and which equipment was not.
・ Of the equipment that can be powered by DC, operators checked to see whether the Unit 1 IC and HPCI equipment were functional. It was discovered that the state of the IC valve open/closed indicator could not be determined. As for HPCI, the control panel indicator lights were faintly discernable, but later they blacked out completely and thus HPCI was deemed to be no longer operable. The state of operation of the Unit 2 RCIC could not be determined.
・ Approximately 3:50 - Power to instrumentation was lost, and the reactor water level could

no longer be ascertained.

- Cell phones were inoperable and the only lines of communication between the Main Control Room and Power Station Emergency Countermeasures Headquarters (hereafter abbreviated "Emergency Countermeasures Headquarters") by then were hotline and landline phones.

[State of Units 3 & 4 Main Control Room]

- With the complete loss of AC power, the only lighting in the Main Control Room was the emergency lighting. Unit 4 was shut down for periodic inspection outage and all fuels had been removed from the reactor, so using flashlights, attention was focused on Unit 3 and the reactor water level and other parameters were checked.
- In accordance with the Manual for dealing with Total Loss of AC Power, all non-essential loads were cut so as to make the RCIC and HPCI batteries last as long as possible.
- 4:03 p.m. - The RCIC was started manually, the discharge pressure and rpm rate were checked and operation monitored from within the Main Control Room, and HPCI startup preparations were made.

[State of Units 5 & 6 Main Control Room]

- It was found that two of the Unit 5 DG and two of the Unit 6 DG had all stopped at the same time due to the tsunami. Frequency control was performed on the one DG belonging to Unit 6 that was still in operation and the operative state was maintained.
- The Unit 5 Main Control Room lighting was lost with only emergency lighting still on, but even the emergency lighting gradually faded away and darkness prevailed. Unit 6 lighting was in its normal state.

Connecting temporary battery to power instrumentation

[Work to restore instruments in Main Control Room]

- In the effort to restore instrumentation within the Main Control Room, the Emergency Countermeasures Headquarters Restoration Team gathered the necessary drawings and **began collecting batteries and cables from companies located on the power station grounds. Items collected were carried into the Main Control Room without delay and the team promptly began connecting them to the instrument panels in the Units 1 & 2 Main Control Room while referring to the diagrams.** The state of "emergency core cooling system water injection non-functional"

Reading a gauge with the help of a flashlight.

occurred, and since the ability to know the state of water injection into the reactor was the utmost priority, the team began the task of restoring power starting by connecting the batteries to the DC-powered reactor water level gauge.

- At 9:19 p.m. the Unit 1 water level was ascertained and Unit 2 likewise at 9:50 p.m.
- In order to restore temporary lighting in the Main Control Room, the Emergency Headquarters Restoration Team prepared a small portable electric generator and installed it. Temporary lighting was restored to the Main Control Room of Units 1 & 2 at 8:49 p.m. and then likewise to the Units 3 & 4 Main Control Room at 9:58 p.m.

[Start of securing power and restoration work]

<Securing power generating trucks>

- Orders were issued from Headquarters Distribution Department to all points to secure high and low voltage power generating trucks and to check the routes to Fukushima Daiichi Power Station.
- All high and low voltage power generating trucks departed from their respective bases bound for Fukushima, **but due to road damage and traffic congestion they were not able to travel the route as it had been expected.** A plan to have the Japan Air Self Defence Force airlift the high and low voltage power generating trucks was also considered, but due to the fact that the trucks exceeded the weight capacity, neither the JASDF nor the American military could perform the airlift and the plan was abandoned. A request was made to Tohoku Electric Power Company to dispatch a high voltage power generating truck to Fukushima Daiichi.

<Checking the integrity of power source equipment>

- The result of the integrity check of the equipment revealed that **early restoration of external power would not be possible because the switches in the switchyard were down and therefore not usable, and further, the DG were inoperable because the main engine and/or other components were completely submerged under water**, and for these reasons it was determined that power generating trucks would be needed to restore power.
- Visual checks were made of the electric power panels (M/C and P/C) in the turbine buildings (some of the equipment was outside the turbine building) as to the state of inundation and damage, and insulation resistance tests carried out, and it was determined that all M/C and P/C belonging to both Units 1 & 3 were completely unusable, Unit 2 M/C were all unusable but the P/C were partially usable (it was later determined that four units out of the seven were usable).

<Preparations for the arrival of power generating trucks by power station employees>

- In view of the fact that the SLC pump machinery require 480 volts in order to operate, the power generating truck was connected to the primary side of the motor transformers

(6.9kV/480V) of the Unit 2 P/C that were still usable.

- **Taking into consideration the distance to** the Unit 2 **P/C and the ability to lay the cables,** it was decided that **the power truck would be situated beside the Unit 2 turbine building, and approximately 200 meters of cable would be laid from there to the P/C on the 1st floor on the north side of the turbine building by going through the truck bay door.**
- The cable was brought into the building using a 4-ton UNIC vehicle that was kept on hand by a company located within the grounds for use during regular outages.

<Arrival of power trucks>

- From late night on March 11 through early morning of March 12, the trucks borrowed from Tohoku Electric Power Company and those belonging to Tokyo Electric Power Company arrived one at a time.
- When the power trucks were being hooked up, priority was given to using TEPCO's own power trucks.

<Work of laying cables and connecting power>

- **The cable laid inside the building is more than 10cm in diameter and 200 meters in length, weighing more than one ton.** Normally, **the work would be done using machinery and would take many days to lay the cables, but here it was carried out using man-power of 40 employees and done at a rapid pace,** completing the work in about four to five hours time.

Road subsidence

- The work was made very difficult **due to the darkness, pools of standing water from the tsunami, scattered debris obstructing the way, missing manhole covers on the roads, and generally poor working conditions.** The work was especially onerous, searching in the darkness for places to punch through in order to lay the cables, breaking down doors to secure the route and so on. To make it worse, **large-scale tsunami warnings continued and frequent aftershocks shook the premises, and work was constantly constrained by the need to take refuge**.
- The work of connecting the crucial cables to the P/C terminals itself took several hours and was done by a number of engineers.
- In order for the work to proceed, Emergency Countermeasures Headquarters and workers in the field would need to communicate reports and instructions back and forth, but **communications equipment was barely operable, making it necessary to change locations** in order to communicate, thereby delaying communications.
- About 3:30 p.m. - **Cable connections were made to the primary side of the usable Unit 2**

P/C from the high voltage power trucks standing by, and power transmission to the SLC pump was only moments away when at 3:36 p.m. there was an explosion at Unit 1. **Flying debris from the explosion damaged the cables that had been laid and the high voltage power trucks automatically shut down.** Work was interrupted and all personnel took refuge in the seismic damping isolation bunker.

[Checking the state of water injection into reactors]

<Checking the state of operation of and operating Unit 1 IC>

- Possibly because the DC power supply was temporarily restored, the indicator lamps in the Main Control Room for the return-pipe isolation valve (MO-3A) and supply-pipe isolation valve (MO-2A) were found to be lit up. When the status of the indicators was checked, it was found that the lamps indicated the valves closed, so at 6:18 p.m. the valve-open operation was performed and it was confirmed that the indicator lamps changed status from closed to open. After the valve-open operation was performed, steam generation was confirmed.
- Later, at 6:25 p.m., after the return-pipe isolation valve (MO-3A) was closed, at 9:30 p.m. the return-pipe isolation valve (MO-3A) was opened and steam generation was confirmed.

<Checking the state of operation of and operating Unit 2 RCIC>


Self-contained breathing apparatus

- Early morning March 12 - Shift workers made field confirmations of the state of operation. **Equipment used consisted of self-contained breathing apparatus, small flashlights, and boots. With frequent aftershocks and the constant threat of more tsunami waves, workers donned their self-contained breathing apparatus which is not a normal part of the job, and field checks that normally took about 10 minutes now required close to an hour.**
- Around 1:00 a.m. - **Depth of water** flooding the RCIC room **came nearly up to the top of their boots**. A faint metallic-like sound could be heard, but it was not possible to clearly make out the revolving parts, so the worker(s) returned to the Main Control Room without being able to confirm that RCIC was in operation. Due to being unable to communicate via cell phone, the worker(s) returned to the Main Control Room to report the findings.
- **Later at around 2:00 a.m., reconfirmation took place. Water flooding the RCIC room had increased in volume, and it was not possible to confirm the state of operation.** Reactor pressure and RCIC pump discharge pressure were confirmed by means of the RCIC instrument rack in the field, and **since the RCIC pump discharge pressure was high, it was determined that the RCIC was functioning**, and this was reported back in the Main

Control Room. At 2:55 a.m., Emergency Countermeasures Headquarters was notified.

END

Chronology of Main Events at Fukushima Daiichi Nuclear Power Station Unit 1 from Impact of Earthquake through Saturday, March 12

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Friday, March 11, 2011

14:46	**Tohoku-Chihou-Taiheiyo-Oki Earthquake strikes. Automatic reactor SCRAM.** Automatic proclamation of Level 3 State of Emergency.
14:47	Automatic shutdown of main turbine, emergency diesel generators start up automatically.
14:52	Isolation Condenser (IC) starts up automatically.
15:02	Reactor subcriticality confirmed.
15:03(approx.)	Manual shutdown of the IC so as to regulate reactor pressure with the IC. Subsequently, reactor pressure regulation via IC begins.
15:06	Extraordinary Disaster Countermeasures Headquarters established at company Head Office (assess extent of earthquake damage, restore lost power)
15:27	Arrival of first tsunami wave.
15:35	Arrival of second tsunami wave.
15:37	Total loss of AC power.
15:42	**A specified event (complete loss of AC power) in accordance with stipulations of Article 10, Paragraph 1 of the Nuclear Disaster Special Measures Law (hereafter abbreviated "Nuclear Disaster Law")was determined to have occurred, government and other authorities were notified.**
15:42	First state of emergency declared. Emergency Countermeasures Headquarters established (merged with Emergency Disaster Countermeasures Headquarters).
16:36	**Reactor water level could not be confirmed and state of water injection was unknown, thus a specified event (emergency core cooling system water injection impossible) in accordance with stipulations of Article 15 Paragraph 1 of Nuclear Disaster Law was determined to have occurred, government and other authorities were notified at 16:45.**
16:36	Second state of emergency declared.
16:45	Reactor water level was confirmed, thus a specified event (emergency core

cooling system water injection impossible) in accordance with the stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Law was determined to be rescinded, government and other authorities were notified at 16:55.

17:07 Confirmation of reactor water level again became impossible, thus a specified event (emergency core cooling system water injection impossible) in accordance with stipulations of Article 15 Paragraph 1 of Nuclear Disaster Law was determined to have occurred, government and other authorities were notified at 17:12.

17:12 Site superintendent gave orders to commence investigation of ways to pumping water into the reactor using fire protection system lines installed as an accident management measure as well as fire trucks.

17:30 Diesel-driven fire-fighting pump started up (standby).

18:18 IC return-pipe isolation valve (MO-3A) and supply-pipe isolation valve (MO-2A) opened, steam generation confirmed.

18:25 IC return-pipe isolation valve (MO-3A) closed.

20:49 Main Control Room lit up by temporary lighting.

20:50 Fukushima prefectural authorities issue evacuation directive to residents living within 2-km radius of Fukushima Daiichi Nuclear Power Station.

21:19 Reactor water level confirmed, Top of Active Fuel (TAF) + 200mm.

21:23 Prime Minister issued directive for evacuation within 3 km radius and take refuge indoors within 3 km to 10 km radius of Fukushima Daiichi Nuclear Power Station.

21:30 IC return-pipe isolation valve (MO-3A) opened, steam generation confirmed.

21:51 Entry into reactor building banned due to rising radiation dose inside the building.

22:00 Reactor water level confirmed to be TAF+550mm, government and other authorities were notified at 22:20.

23:00 Government and other authorities were notified at 23:40 of survey results showing rising radiation dose levels inside turbine building (1.2mSv/h in front of turbine 1st floor north-side airlock and 0.5mSv/h in front of turbine 1st floor south-side airlock).

Saturday, March 12, 2011

0:06 Possibility of drywell pressure exceeding 600kPa abs, thus orders given by Site Superintendent to prepare for possible venting of containment

vessel (hereafter abbreviated "vent/venting").

0:30 Government confirms completion of measures for evacuating residents (confirmed measures for evacuating residents of Futaba-machi (town) and Ookuma-machi (town) within 3 km, reconfirmed at 1:45)

0:49 Possibility exists that drywell pressure may have exceeded 600kPa abs, so a specified event (abnormal rise in containment vessel pressure) in accordance with stipulations of Article 15 Paragraph 1 of Nuclear Disaster Law was determined to have occurred, government and other authorities were notified at 0:55.

1:30(approx.) Proposal to vent Unit 1 and Unit 2 made to Prime Minister, Minister of Economy, Trade and Industry, and Nuclear and Industrial Safety Agency (NISA) and consent obtained.

1:48 Confirmation that the diesel-driven fire-fighting pump had shut down due to malfunction. Consideration given to connecting fire protection system lines from fire-trucks for supplying water.

2:47 Government and other authorities were notified that the drywell pressure had reached 840kPa abs as of 2:30.

3:06 Press conference held to announce venting measures.

4:01 Estimation of radiation exposure as the result of venting notified to government and other authorities.

4:55 Rise in radiation dose within power station grounds discovered (0.069 μSv/h (4:00) → 0.59 μSv/h (4:23) in area around main gate), government and other authorities notified.

5:14 Government and other authorities were notified that "radioactive materials leaked into the environment" was determined to have occurred based on the increased radiation dose within power station grounds and the falling tendency of drywell pressure.

5:44 Prime Minister issued directive for all residents within 10 km radius from Fukushima Daiichi Nuclear Power Station to evacuate.

5:46 Using fire-engines to inject fresh water into reactor via the fire protection system lines started.

5:52 Conclusion of fire-engines injecting 1,000 liters of fresh water via fire protection system.

6:30 Conclusion of fire-engines injecting 2,000 liters (aggregate) of fresh water via fire protection system.

6:33 State of evacuation of the area is that mass-migration of residents from

	Ookuma-machi toward direction of Miyakoji-machi is under consideration.
6:50	Minister of Economy, Trade and Industry orders venting under authority of law (manual venting).
7:11	Prime Minister arrived at Fukushima Daiichi Nuclear Power Station.
7:55	Conclusion of fire-engines injecting 3,000 liters (aggregate) of fresh water via fire protection system.
8:03	Site Superintendent issued directive to conduct venting with 9:00 a.m. as the target time.
8:04	Prime Minister departed from Fukushima Daiichi Nuclear Power Station.
8:15	Conclusion of fire-engines injecting 4,000 liters (aggregate) of fresh water via fire protection system.
8:27	A report was received that not all residents of Ookuma-machi had been evacuated yet.
8:30	Conclusion of fire-engines injecting 5,000 liters (aggregate) of fresh water via fire protection system.
8:37	Fukushima prefectural authorities were notified that preparations are being made to begin venting at around 9:00 a.m. Timing of venting adjusted to completion of evacuation.
9:03	Completion of Ookuma-machi (Kumachiku district) evacuation confirmed.
9:04	**Shift workers set out toward field in order to conduct venting.**
9:05	Start of venting announced to press.
9:15	Conclusion of fire-engines injecting 6,000 liters (aggregate) of fresh water via fire protection system.
9:15(approx.)	Containment vessel (PCV) valve (MO valve) manually opened.
9:30(approx.)	Field attempt to operate Suppression Chamber (S/C) small valve (AO valve) made, but abandoned due to high radiation dose level.
9:40	Conclusion of fire-engines injecting 21,000 liters (aggregate) of fresh water via fire protection system.
9:53	Estimated radiation exposure if venting is implemented notified to government and other authorities.
10:17	S/C vent valve (AO valve) small valve opened from within the Main Control Room (with the expectation that there is some remaining pressure in the instrumentation compressed air system)
10:40	It was discovered that radiation dose was on the rise at the front gate and monitoring posts, thus it was judged that there is high possibility that radioactive material had been emitted through venting.

11:15 Radiation dose is falling, thus indicating that venting was not likely sufficiently effective.

11:39 Government and other authorities were notified that one Tepco employee was exposed to dose greater than 100 mSv (106.30mSv) when entering into the reactor building in order to conduct venting.

14:30 It was determined that "radioactive materials were released into the atmosphere" through the venting operation when, in order to operate the S/C vent valve (AO valve) large valve, a temporary air compressor was installed at around 14:00, and at that time it was learned that the drywell pressure had fallen, and this was notified to government and other authorities at 15:18.

14:53 Total (aggregate) of 80 tons of fresh water injected into reactor by fire-engines.

14:54 Site Supervisor gave order to pump seawater into reactor.

15:18 Work to restore Stand-by Liquid Control system goes forward, Stand-by Liquid Control pump is started as soon as preparations are made, and it is planned to inject boric acid liquid into the reactor. Also, government and other authorities were notified that as soon as preparations have been made, it is planned to pump seawater into the reactor via the fire protection system.

15:36 Preparations for pumping water into the reactor via the Stand-by Liquid Control system are complete, using the restored power furnished by the power generating trucks.

15:36 Reactor building explodes.

16:27 Radiation dose exceeding 500 μ Sv/h detected at monitoring post (1,015 μ Sv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Law was determined to have occurred, government and other authorities were notified .

17:20(approx.) Personnel set out to investigate the condition of fire-trucks, buildings, and the like.

18:05 The fact that the Minister of Economy, Trade and Industry had given orders under authority of law was shared between Head Office and power station.

18:25 Prime Minister issued directive for residents within 20 km radius from Fukushima Nuclear Power Station to evacuate.

18:30(approx.) Results of investigation of condition of fire-trucks, buildings and the like confirmed that the field was littered with scattered debris and **Stand-by**

Liquid Control power supply equipment and hoses that had been prepared for pumping in seawater were damaged and could not be used.

19:04 **Pumping seawater into reactor via fire protection system lines using the fire-trucks began.**

20:45 Mixing boric acid with seawater and pumping it into the reactor started.

END

Fukushima Daiichi Nuclear Power Station Unit 1
State of Alternate Coolant Injection

This document is compilation of facts as they are known at the present time based on a variety of report and eye witness accounts. If and when new facts come to light hereafter as the investigation continues, they will be disclosed at that time.

◆ **Details of actions following "determination and notification of emergency core cooling system water injection malfunction at 16:36 on March 11"**

[Alternative injection methods considered]

- Work proceeded under the hardship such as **conditions of continual large-scale tsunami warnings, work interruptions due to taking refuge from aftershocks, non-existence of lighting and lines of communications, and added to all of that, the rubble and soil and sand washed up by the tsunami.**
- 17:12 - **Alternate methods of coolant injection (fire protection systems, make up water condensate system, containment coolant system) established as accident management measures and the use of fire trucks using fire protection cisterns set up as a lesson learned from the Chuetsu-oki Earthquake** are considered.
- In the Main Control Room, the Accident Management Manual was placed on the Shift Supervisor's desk in order to check the alternate coolant injection methods, and **checking the alternate coolant injection lines to the reactor** and putting the diesel-driven fire protection pump into use proceeded.
- For pumping water into the reactor, **in order to set up an alternate coolant injection line using the diesel-driven fire protection pump and passing through the fire protection system lines through the reactor core spray system, core spray system valves were manually opened in the reactor building in the pitch darkness**, so that injection could begin once the reactor becomes depressurized to below 0.69MPa.
- 17:30 - The diesel-driven fire protection pump was started up (standby mode).
- The Emergency Countermeasures Headquarters Restoration Team found that **electric panels (metal-clad switch gears and power centers) were submerged under water and appeared to be in damaged condition, and they tested the insulation resistance,** and confirmed that those for Unit 1 were all unusable, but one of the Unit 2 power centers was usable. As for the possibility of high-pressure injection Standby Liquid Control system (SLC), consideration is given to **using power restored by the power generating trucks via the Unit 2 power center**.

- **Monitoring instruments** in the Main Control Room **were useless due to lack of power, and therefore it was necessary to go into the reactor building in the pitch darkness,** and the reactor pressure gauge was checked and pressure was confirmed to be 6.9 MPa (20:07). Later, at 21:19, the reactor water level gauge was restored, and the water level was confirmed to be at Top of Active Fuel (TAF) +200 mm.

◆ **Details of actions following "start of consideration given to connecting fire protection system lines from fire-trucks to the water supply outlet at 1:48 on March 12."**

[Restoration of diesel-driven fire protection pump]

- 1:48 - At some point in time, the diesel-driven fire protection pump that was standing by to pump coolant into the reactor had stopped running, so **in order to restore the pump, diesel fuel was carried in by hand and supplied to the pump, and batteries being stored by on-premises companies were brought in, the batteries were changed and other methods of restoration** were attempted, but the pump could not be restarted.

[Preparations to inject coolant using fire-engines]

- Water was gushing out from the fire hydrants and it was found that filtered water could not be sourced for use, and therefore **in order to obtain filtered water, surrounding valves were shut off.** In addition, **other sources of water were searched for and it was found that the fire protection cisterns could be used.**

Road on station grounds

- Work proceeded to make use of one of the fire-engines deployed on the station grounds. Of the other two fire-engines, one of them was destroyed by the tsunami, and the other one could not be used because it could not be brought over from the Units 5 & 6 side. (the road was damaged and debris from the tsunami cut off the route connecting the Units 5 & 6 side.)

Tank washed up by tsunami

- **There were numerous obstacles to getting the one usable fire-engine to the deployment site near Unit 1. The road passing in front of the former main office building was impassible due to a tank that had been washed into the road by the tsunami blocking passage. The gate to Protection Headquarters could not be opened because there was no electric power. The Emergency Countermeasures Headquarters Restoration Team searched for passable routes within the station grounds, then the lock on the gate between Units 2 and 3 had to be broken to get the gate opened, and thus the route for the vehicles was secured.**
- Regarding the fire-trucks, consideration was given to pumping water to the reactor

coolant injection line from the fire protection system line water supply outlets, and preparations were also made for bringing in another fire-engine and having the Self Defence Forces haul in water.

- 2:45 - The reactor pressure was confirmed to be 0.8MPa.

[Restoration of SLC system]

- The electrical panels and pumps of the SLC system were not affected by the seawater, and since SLC was capable of injecting coolant to the reactor at high pressure, work began restoring the power to the Unit 2 power center from the power generating trucks.

◆ **Details of actions following "Start of using fire-engines to inject fresh water into reactor via the fire protection system lines at 5:46 on March 12"**

[Start of injecting fresh water and continuation thereof]

- One of the fire trucks on standby in the garage was moved to Unit 1. At first it was thought that the discharge pressure would be insufficient when pumping from the Unit 1 side fire protection cistern position, **so water was drawn from the fire protection cistern, then the fire truck was moved closer to the building, and cooling water was injected from the fire protection system water supply outlet into the reactor repeatedly**. When the fire truck plied back and forth, **caution had to be exercised as it passed by buildings that were on the verge of crumbling, therefore requiring a great deal of time for the operation**.
- **Many obstacles that were affected by the earthquake and tsunami hindered the passage of the fire truck, causing it to take a great deal of time**, and so after **trial and error**, the hoses from the fire truck were used, continuous lines for water injection were established between the Unit 1 fire protection cistern and the fire protection water supply outlet and the coolant injection continued.
- The additionally requisitioned fire truck arrived, and **fresh water was carried** from the Unit 3 fire protection cistern to the Unit 1 fire protection cistern **over and over**. **Only one hose could be inserted into the fire protection cistern, and so whenever fresh water was being supplied, the injection side hose to the reactor had to be removed, resulting in that the injecting had to be interrupted each time**.

[Start of seawater injection and SLC injection preparations]

- There is a limit to the amount of fire protection cistern fresh water that can be

secured, and so preparations started being made for pumping in sea water.

- **Judging based on the condition of the roads within the station grounds and distance from the sea to Unit 1, it was decided not to take seawater directly from the ocean, but instead to use seawater from the tsunami flooding the Unit 3 backwash valve pit as the source.**

Pumping water into reactor with fire trucks (deployment later)

- 14:53 - Eighty thousand (80,000) liters (aggregate) of fresh water had so far been pumped in.
- 14:54 - Orders came down from the Site Supervisor to begin preparations for pumping seawater into the reactor. The Unit 1 fire protection cistern fresh water was running out, so in addition to urgently transporting fresh water from other fire protection cisterns, work of switching over to pumping in seawater went ahead.
- **Approximately 15:30 - Cables inside the building are connected to the primary side of the P/C, and connection to the high-voltage power generating truck was complete, and power was within fingertips reach of the SLC pump**.
- Using water in the Unit 3 backwash valve pit as the source (seawater from the tsunami retained inside the pit), seawater was pumped in by **forming the injection line by connecting three fire trucks in series so as to attain the required head**.

- 15:36 - **Unit 1 reactor building explodes.**
  - **The site was evacuated** because of the explosion and **the injured were rescued and carried to safety**. (three Tepco employees and two contractors)
  - **Site survey and check to investigate the effects of the explosion in order to maintain safety**. (condition of the fire trucks, extent of damage to the building, presence of smoke, and the like)

Unit 1 reactor building explosion

Windows on the fire-engine were broken, but functionality was not damaged.

  - **The cables that had been laid to the SLC pump were damaged by flying debris from the explosion, and the high-voltage power generating truck shut itself down automatically.**
  - **The hose that had been readied for pumping in seawater was damaged**.

- **The site was evacuated, a head-count and safety check was conducted, and until the conditions in the field could be checked, restoration work could not be continued**.
- The area surrounding Unit 1 was **strewn with highly radioactive debris scattered by the explosion, and so cleanup of the debris (such as steel plates from the Unit 1 reactor building and the like) under the monitoring of the radiation control personnel, and hoses were gathered up from outside fire hydrants and work was resumed to re-route the hoses to reconstruct the line**.
- 19:04 - Pumping in of seawater into the reactor by way of fire protection lines and fire-engines began.

End

Fukushima Daiichi Nuclear Power Station Unit 1
Circumstances of Venting of Containment Vessel

This document is compilation of facts as they are known at the present time based on a variety of report and eye witness accounts. If and when new facts come to light hereafter as the investigation continues, they will be disclosed at that time.

◆ **Details of actions following "determination and notification of emergency core cooling system water injection malfunction at 16:36 on March 11"**

・ While work was being performed to restore the instruments in the Main Control Room, the following work was also being carried out.

[Preparation for venting]

・ In the Main Control Room, an Accident Management (AM) Procedures manual was placed on the desk of the Shift Supervisor and its contents were checked. In addition, **a valve checklist was used, and confirmation began as to which valves were needed for venting and the locations of each.**

・ The Power Station Emergency Countermeasures Headquarters (abbreviated "Emergency Countermeasures Headquarters") Power Team **deliberated on venting procedures under no-power conditions** as they referred to the AM Procedures manual.

・ **As aftershocks continued rocking the power station**, the Emergency Countermeasures Headquarters Restoration Team **entered the Main Office building, which was then designated as off limits, in order to retrieve the blueprints so as to confirm the type and structure of the S/C vent valve (AO valve) needed for the venting operation to determine whether they could be opened manually or not**, as well as making inquiries to contractors. As the result of checking the blueprints, it was confirmed that **the S/C small vent valve (AO valve) had handles and therefore could be opened manually**, and this information was conveyed to the Main Control Room.

Main Office Damage

[Beginning of rising radiation dose in the field]

・ 21:51 - **Reactor building designated as off limits** due to **rising radiation dose levels in the building**.

・ Around 22:00 - the Emergency Countermeasures Headquarters Restoration Team was notified that the alarm pocket-type dosemeters (APD) reached 0.8mSv within a very short time in the field inside the reactor building.

・ 23:00 - **Radiation dose levels rise inside the turbine building** (1.2 mSv/h in front of turbine 1st floor north side airlock, 0.5 mSv/h in front of 1st floor south side airlock) due to the influence of rising radiation in the reactor building.

[Discovery of rising pressure in the drywell]

・ Approximately 23:50 - In the Main Control Room, the Emergency Countermeasures Headquarters Restoration Team connected the small-scale portable generator installed in the Main Control Room for temporary restoration of lighting to the drywell pressure gauge and found that the pressure reading was 600kPa abs, and this was notified to Emergency Countermeasures Headquarters.

◆ **March 12 at 0:06 - Details of actions taken after "possibility that drywell pressure may have exceeded 600kPa abs, ... Station Director gives orders to begin [venting] preparations"**

[Start of specific deliberation on venting procedures]

・ Piping & instrumentation diagrams, AM procedures, valve diagrams, and other documents, and an acrylic whiteboard were brought into the Main Control Room, and procedures such as valve operation methods et cetera were studied in concrete detail.

・ Around 1:30 - The proposal to vent was made to the Prime Minister, the Minister of Economy, Trade and Industry, and the Nuclear and Industrial Safety Agency (NISA) and consent was obtained, and a report was provided **from the Head Office Task Force stating, "We want you to use any possible way of operating the MO valves and AO valves to conduct venting. The Minister of Economy, Trade and Industry and our company will issue a statement regarding venting at 3:00. Begin venting when the announcement has been made."**

[Discussion of venting procedures continue]

・ 2:24 - The estimated work-time in the field required for venting operations was reported to Emergency Countermeasures Headquarters. It was reported that **in the atmosphere with dose rate of 300 mSv/h and given the dose limit in case of emergency being 100 mSv/h, work time would be limited to 17 minutes** (self-contained breathing apparatus is good for 20 minutes, and taking iodine supplement required).

・ 2:30 - Drywell pressure found to have reached 840 kPa abs (maximum operating pressure 427 kPa gage*).

*528.3 kPa abs (= 427 kPa gage+101.3 kPa)

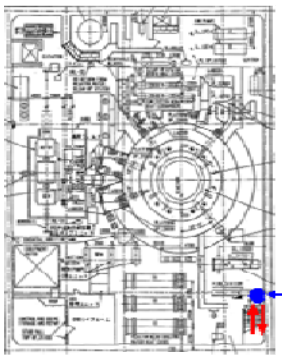
・ Approximately 3:45 - Head Office Task Force prepares dose estimate for the area when venting is performed and shares this with power station. Meanwhile, at the power station, **when the airlock was opened in order to measure the dose inside the reactor building, a "white haze" could be seen and the airlock was quickly closed. The dose could not**

be measured.

- In the Main Control Room, **venting preparations were under way and the sequence of valve operation, valve position in the Torus chamber, height of the valve, and the like, and these were checked and re-checked**. Also, equipment that would be needed for the job, such as fireproof clothing, self-contained breathing apparatus, APD, survey meters, and flashlights were **collected to the extent possible**.
- Around 4:30 - **Emergency Countermeasures Headquarters notifies the Main Control Room that due to possible tsunami caused by aftershocks, field operations were prohibited.**
- Around 4:45 - APDs set to 100mSv and full face masks are delivered to the Main Control Room from Emergency Countermeasures Headquarters. About 4:50, contamination was found on workers who had taken refuge in the seismic-isolation building, **so when setting out for the field, "full face masks + charcoal filters + B-gear, C-gear, and coveralls" were worn from the point of leaving the entrance of the seismic-isolation building**. Later, at around 5:00, **directives for donning the same sort of gear "full face masks + charcoal filters + B-gear" in the Main Control Room were issued.**
- Radiation dose is on the rise in the Main Control Room, so the Shift Supervisor has the shift personnel move to the Unit 2 side, where the dose is lower.
- 6:33 - It was confirmed that as a regional evacuation measure, moving residents from Okuma-machi (town) toward the direction of Miyakoji was under consideration.
- 8:03 - The Station Director gave instructions for Unit 1 venting to start around 9 o'clock.
- In the Main Control Room, **it was decided to form three teams of two persons each (Shift Supervisor and Assistant Shift Supervisor) since it was pitch-dark in the work area to execute the task by one person, high radiation dose was expected, and retreating due to aftershock was anticipated**.
- The status of evacuation of residents was checked, and the TEPCO employee on dispatch to Okuma-machi town office reported back to Emergency Countermeasures Headquarters at 8:27 that **the town of Okuma-machi was not completely evacuated yet**.
- 8:37 - Notified Fukushima Prefectural authorities that preparations were being made with a view to begin venting at 9:00. **Timing coordinated to start venting when evacuation procedures are complete.**
- 9:03 - Confirmation that Okuma-machi (Kuma district) evacuation is complete. Prefectural authorities notified of venting at 9:05 a.m.

◆ **Details of actions taken after "March 12, 9:04 - Shift personnel set out to field for venting"**

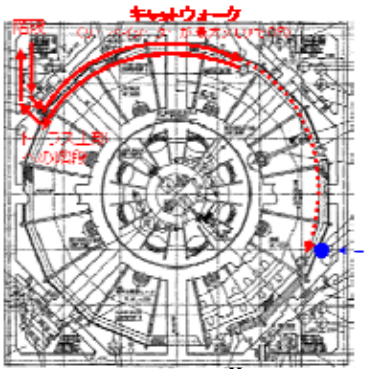
[PCV vent valve (MO valve) opened]



R/B 2F

- 9:04 - Two shift personnel set out for field to perform PCV venting. Equipment: **fireproof clothing, self-contained breathing apparatus, and APD**. Because of the **total darkness in the field** in both the reactor building and turbine building due to loss of power, they set out carrying flashlights. **Because there is no means of communication, and once a team leaves for the field there is no way to get in touch, one team at a time is sent into the field and the next team sets out when the previous team returns to the Main Control Room.**
- Team No. 1 departs Main Control Room for field in order to open the PCV vent valve (MO valve). At around 9:15, 25% open is accomplished as planned and the team returned to the Main Control Room. Radiation exposure dose is about 25 mSv.

[Opening S/C small vent valve (AO valve)]



R/B B1

- Team No. 2 sets out from Main Control Room at 9:24 heading for the Torus chamber in order to open the S/C small vent valve (AO valve). **On the way, radiation rises**, and there is the possibility of exceeding the dose limit of 100 mSv, so at about 9:30 the team turn back.
- Team No. 3 mission is cancelled due to high radiation dose. Emergency Countermeasures Headquarters notified.

[Plans deliberated for opening S/C large vent valve (AO valve)]

- Having received notification that the S/C small vent valve (AO valve) could not be opened, the Emergency Countermeasures Headquarters begins thinking about the location for connecting a temporary compressor (until about 11:00). Also, instructions are given to open the S/C small vent valve (AO valve) from the Main Control Room, placing hopes on remaining air pressure in the S/C small vent valve (AO valve).

[Remote control opening of S/C small vent valve (AO valve) (placing hope on remaining air pressure in the instrument air system) and rising indicated values at Monitoring Post (MP)]

- 10:17 - First attempt to open made, but unclear if the valve opened.
- 10:23 - Second attempt to open made, but unclear if the valve opened.
- 10:24 - Third attempt to open made, but unclear if the valve opened.

・ 10:40 It is discovered that radiation level is rising at the main gate and MP, thus Emergency Countermeasures Headquarters makes the judgement call that it is highly likely that radioactive materials must have been emitted through the venting, but at 11:15, the radiation had fallen, confirming the likelihood that venting was not sufficiently effective.

[Opening of S/C large vent valve (AO valve)]

・ As the Emergency Countermeasures Headquarters Restoration Team searched for a temporary compressor, it was reported that a contractor company had one, so it was decided to go to the contractor's office looking for it. But the temporary compressor could not be connected without an adaptor, so referring to piping and instrumentation diagrams, thought was given to finding a place where it could be connected, and a spot for installation was chosen. In the field, a photo of the chosen spot was taken and [the personnel] returned to Emergency Countermeasures Headquarters.

・ Approximately 12:30 - In addition to going to look for an adaptor, a temporary compressor was found at the office of a contractor, and it was transported using a UNIC vehicle. Due to high radiation, it was installed outside of the truck bay door to the reactor building. The temporary compressor was started up at around 14:00.

・ **14:30 - It is learned that the drywell is becoming depressurized, and judged that "release of radioactive materials" occurred due to venting.**

Drywell pressure: 0.75MPa→0.58MPa (14:50)

END

Chronology of Main Events at Fukushima Daiichi Nuclear Power Station Unit 2 from Impact of Earthquake through Tuesday, March 15

This document is compilation of facts as they are known at the present time based on a variety of report and eye witness accounts. If and when new facts come to light hereafter as the investigation continues, they will be disclosed at that time.

Friday, March 11, 2011

14:46	Tohoku-Chihou-Taiheiyo-Oki Earthquake strikes. Automatic proclamation of Level 3 State of Emergency.
14:47	Automatic shutdown of main turbine, emergency diesel generators start up automatically.
14:50	Reactor Core Isolation Cooling system (RCIC) manual startup.
14:51	RCIC shutdown (reactor water level high).
15:01	Reactor subcriticality confirmed.
15:02	RCIC manual startup
15:06	Extraordinary Disaster Countermeasures Headquarters established at company Head Office (assess extent of earthquake damage, restore lost power)
15:27	Arrival of first tsunami wave.
15:28	RCIC shutdown (reactor water level high).
15:35	**Arrival of second tsunami wave.**
15:39	**RCIC manual startup.**
15:41	Total loss of AC power.
15:42	**A specified event (complete loss of AC power) in accordance with stipulations of Article 10, Paragraph 1 of the Nuclear Disaster Special Measures Law (hereafter abbreviated "Nuclear Disaster Law") was determined to have occurred, government and other authorities were notified.**
15:42	First state of emergency declared. Emergency Countermeasures Headquarters established (merged with Emergency Disaster Countermeasures Headquarters).
16:36	**Reactor water level could not be confirmed and state of water injection was unknown, thus a specified event (emergency core cooling system water injection impossible) in accordance with stipulations of Article 15 Paragraph 1 of Nuclear Disaster Law was determined to have occurred,**

government and other authorities were notified at 16:45.

16:36 Second state of emergency declared.

17:12 Station Director gave orders to commence investigation of ways to pump water into the reactor using fire protection system lines installed as an accident management measure as well as fire trucks.

20:49 Main Control Room lit up by temporary lighting.

20:50 Fukushima prefectural authorities issued evacuation directive to residents living within 2-km radius of Fukushima Daiichi Nuclear Power Station.

21:02 Reactor water level unknown, could not confirm coolant injection into reactor via RCIC, thus the possibility that reactor water level may have reached Top of Active Fuel (TAF) was notified to government and other authorities.

21:13 Estimate to reach TAF at 21:40, government authorities were notified.

21:23 Prime Minister issued directive for evacuation within 3km radius and take refuge indoors within 3km to 10km of Fukushima Daiichi Nuclear Power Station.

22:00 Reactor water level was established and it was confirmed to be TAF+3400 millimeters, thus it was estimated that there was still some time remaining until TAF would be reached, so government and other authorities were notified at 22:10 and again at 22:20.

Saturday, March 12, 2011

0:30 Government confirmed completion of measures for evacuating residents (confirmed measures for evacuating residents of Futaba-machi(town) and Ookuma-machi(town) within 3-km, reconfirmed at 1:45)

1:30(approx.) Proposal to vent Unit 1 and Unit 2 made to Prime Minister, Minister of Economy, Trade and Industry, and Nuclear and Industrial Safety Agency (NISA) and consent obtained.

2:55 RCIC confirmed to be in operation.

3:06 Press conference held to announce venting measures.

3:33 Estimation of radiation exposure in case of venting notified to government and other authorities.

4:55 Rise in radiation dose within power station grounds discovered (0.069 μSv/h(4:00) → 0.59 μSv/h(4:23) in area around main gate), government and other authorities notified.

5:44 Prime Minister issued directive for all residents within 10km radius from

Fukushima Daiichi Nuclear Power Station to evacuate.

6:50 Minister of Economy, Trade and Industry ordered venting under authority of law (manual venting).

7:11 Prime Minister arrived at Fukushima Daiichi Nuclear Power Station.

8:04 Prime Minister departed from Fukushima Daiichi Nuclear Power Station.

16:27 Radiation dose exceeding 500μSv/h detected at monitoring post (1,015μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Law was determined to have occurred, government and other authorities were notified.

17:30 Directive given by Station Director to begin preparations for venting.

18:25 Prime Minister issued directive for residents within 20km radius from Fukushima Nuclear Power Station to evacuate.

Sunday, March 13, 2011

8:10 Containment vessel (PCV) valve (MO valve) opened.

8:56 Radiation dose in excess of 500μSv/h measured at monitoring post (measured value 882μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of Nuclear Disaster Law was determined to have occurred, government and other authorities notified at 9:01.

10:15 Site Supervisor issued directive to implement venting.

11:00 Configuration of vent line complete except for rupture disk.

11:20 Press release regarding venting.

12:05 Site Supervisor issued directive to prepare for the use seawater.

14:15 Radiation dose exceeding 500μSv/h detected at monitoring post (measured value 905μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of Nuclear Disaster Law was determined to have occurred, government and other authorities notified at 14:23.

15:18 Estimation of radiation exposure in case of venting notified to government and other authorities.

Monday, March 14, 2011

2:20 Radiation dose exceeding 500μSv/h detected at main gate (751μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station

grounds) in accordance with stipulations of Article 15 Paragraph 1 of Nuclear Disaster Law was determined to have occurred, government and other authorities notified at 4:24.

2:40 Radiation dose exceeding 500μSv/h detected at monitoring post (650μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified at 5:37.

4:00 Radiation dose exceeding 500μSv/h detected at monitoring post (820μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified at 8:00.

9:12 Radiation dose exceeding 500μSv/h detected at monitoring post (518.7μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified at 9:34.

11:01 Due to the explosion of Unit 3 reactor building, the suppression chamber (S/C) large vent valve (AO valve) closed. Found to be not possible to open. Coolant injection line for which preparations were completed unusable due to damage to fire truck and hose.

13:05 Reconfigured seawater injection line, including fire truck.

13:18 Reactor water level was dropping, so government and other authorities were notified that preparations were ready to start for pumping seawater into the reactor.

13:25 Dropping water level in the reactor indicated possibility that the RCIC may have become inoperable, thus a specified event (reactor cooling ability lost) in accordance with stipulations of Nuclear Disaster Law Article 15 Paragraph 1 was determined to have occurred, government and other authorities were notified at 13:38.

15:28 Government and other authorities were notified that TAF was expected to be reached at 16:30.

16:30 Fire truck started up in order to inject seawater into reactor.

16:34 Government and other authorities were notified that in addition to start of reactor depressurization, fire protection system lines will begin pumping

seawater into the reactor.

17:17 Reactor water level reaches TAF. Government and other authorities were notified at 17:25.

18:00(approx.) Reactor depressurization begins (reactor pressure 5.4MPa→19:03 0.63MPa)

18:22 Reactor water level reached TAF-3,700 millimeters, fuel rods presumed to be totally exposed. Government and other authorities were notified at 19:32.

19:20 It is discovered that the fire truck being used for pumping seawater into the reactor has run out of fuel and stopped.

19:54 Seawater injection into reactor begins via fire trucks through fire protection system lines (one truck starts up at 19:54, another at 19:57).

21:00(approx.) S/C small vent valve (AO valve) opened. Vent line configuration complete except for rupture disk.

21:20 Two safety-relief valves (SRV) opened, reactor water level confirmed rising, government and other authorities were notified at 21:34 (as of 21:30, reactor water level is at TAF-3,000mm).

21:35 Radiation dose exceeding 500μSv/h detected at monitoring vehicle (760μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of Nuclear Disaster Law was determined to have occurred, government and other authorities were notified at 22:35.

22:50 Drywell pressure is found to be in excess of maximum operating pressure 427 kPa gage, thus a specified event (abnormal rise in containment vessel pressure) in accordance with stipulations of Article 15 Paragraph 1 of Nuclear Disaster Law was determined to have occurred, government and other authorities notified at 23:39.

23:35(approx.) Due to the S/C pressure being below the rupture disk trigger threshold and drywell pressure being on the rise, it was decided to conduct venting by opening the drywell small vent valve.

Tuesday, March 15, 2011

0:02 Drywell small vent valve (AO valve) opened. Vent line configuration complete except for rupture disk (valves confirmed to be closed state a few minutes later).

3:00 Drywell pressure exceeded design specification maximum operating pressure, so procedures for depressurization and coolant injection into reactor are implemented, but depressurization could not be fully accomplished.

Government and other authorities were notified at 4:17.

6:00～6:10(approx.) Loud impact sound emanated from around the area of the suppression chamber.

6:50 Radiation dose exceeding 500μSv/h detected at area around main gate (583.7μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of Nuclear Disaster Law was determined to have occurred, government and other authorities notified at 7:00.

7:00 Government and other authorities were notified that personnel except those essential for monitoring and work operations are being evacuated to Fukushima Daini Power Station.

8:11 Radiation dose exceeding of 500μSv/h detected at area around main gate (807μSv/h), thus a specified event (abnormal radioactive material emitted due to fire and explosion) in accordance with stipulations of Article 15 Paragraph 1 of Nuclear Disaster Law was determined to have occurred, government and other authorities were notified at 8:36.

8:25 White smoke (looks like steam) was coming out from the wall in the vicinity of the 5th floor of the reactor building, government and other authorities were notified at 9:18.

11:00 Prime Minister issued directive for residents within 20 km to 30 km radius from Fukushima Nuclear Power Station to take refuge indoors.

16:00 Radiation dose exceeding 500μSv/h detected at main gate (531.6μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of Nuclear Disaster Law was determined to have occurred, government and other authorities were notified at 16:22.

23:05 Radiation dose exceeding 500μSv/h detected at main gate (4548μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of Nuclear Disaster Law was determined to have occurred, government and other authorities notified at 23:20.

END

Fukushima Nuclear Power Station Unit 2
State of Alternate Coolant Injection

This document is compilation of facts as they are known at the present time based on a variety of report and eye witness accounts. If and when new facts come to light hereafter as the investigation continues, they will be disclosed at that time.

◆ **Details of actions following "determination and notification of emergency core cooling system water injection malfunction at 16:36 on March 11"**

[Alternative injection methods considered]

- **17:12 - Alternate methods of coolant injection (fire protection systems, make up water condensate system, containment coolant system) established as accident management measures and the use of fire trucks using fire protection cisterns set up as a lesson learned from the Chuetsu-Oki Earthquake** are considered.
- In the Main Control Room, the Accident Management Procedure was placed on the Shift Supervisor's desk in order to check the alternate coolant injection methods, and work proceeded **checking the alternate coolant injection lines to the reactor**.
- **In order to configure the alternate coolant injection line via the residual heat removal system for injecting coolant into the reactor**, based on the radiation dose situation of Unit 1, before the radiation becomes high, **the reactor building and turbine building residual heat removal system valves are opened manually in the darkness**, and after depressurization of the reactor to below 0.69MPa, coolant injection becomes feasible.
- The Emergency Countermeasures Headquarters Restoration Team checked the flooding and visual damage condition of the Unit 2 **electric panels (high voltage metal-clad switch gears and power centers) and tested the insulation resistance. As a result one of the power centers was found to be usable.** For the Control Rod Drive system (CRD) and Standby Liquid Control system (SLC) that are capable of injecting coolant at high pressure, consideration was given for **injecting coolant after restoring power to the power center using a power generation truck.**
- 22:00 - The reactor water level gauge was discerned, and Top of Active Fuel (TAF) + 3,400 millimeters was confirmed, thereby confirming that TAF had not been reached.

[Restoring power to alternate method of coolant injection]

The electrical panels and pumps of the CRD and SLC systems were not affected by the

seawater, and since they were capable of injecting coolant into the reactor at high pressure, work began restoring the power to the power centers from the power generating truck.

- 15:30(approx.) - **Cables were connected to the primary side of the Unit 2 P/C that were in usable condition, and connection to the high voltage power generating truck was completed**, but at 15:36 there was an explosion at Unit 1. **Flying debris from the explosion damaged the cables that had been laid and the high voltage power trucks automatically shut down.** Work was interrupted and all personnel took refuge in the **seismic-isolated building**.
- The following day, attempts were made to restart the power generating truck connected to the Unit 2 power center, but the over-current relay was triggered so power could not be supplied.

◆ **Details of actions taken after "Station Director issues directive to prepare for using seawater at 12:05 on March 13."**

[Start of preparations for injecting seawater]

- In preparation for stoppage of the RCIC, so as to make switchover to injection of seawater feasible, work progresses on the configuration of the line that uses the Unit 3 back wash valve pit as the water source, the fire truck is deployed and hoses are laid.

[Reconfiguration of seawater injection after Unit 3 explosion]

- **For safety sake, personnel take refuge after Unit 3 reactor building explodes** on March 14 at 11:01. The coolant injection line that had been made ready was **rendered unusable because of damage to the fire truck and hoses.**
- **Shortly past noon, personnel set out for the field to assess the situation and also to** work on **drawing seawater directly from the shallow draft quay instead of the Unit 3 back wash valve pit which was littered by scattered rubble. Under the high radiation dose condition resulting from the scattered debris and rubble, making use of the usable fire truck and hoses**, work proceeds on **preparations for configuring a new injection line.**
- 13:18 - Reactor water level is falling, and at 13:25 it is determined that the RCIC has stopped functioning. Judging from the situation, it is predicted that TAF will be reached at around 16:30. Work continues making preparations for pumping seawater into the reactor, and at 14:43 connection to the fire protection system via fire truck is completed.

- From after 15:00 until after 16:00, **due to aftershocks off the coast of Fukushima prefecture, work was made difficult by frequent interruptions and taking refuge.**
- Around 16:30, the fire engine was started up, and **preparations were made to begin coolant injection when the reactor is depressurized.**

[Depressurizing the reactor]

- In order to inject coolant using the fire truck, **it was necessary to depressurize the reactor by opening the safety-relief valves (SR valves)**, but given that **the Suppression Chamber (S/C) temperature and pressure were high** (as of 12:30 March 14, S/C temperature was 149.3˚C and S/C pressure 486kPa), **even if the SR valve was opened, the steam in the S/C may not condense, possibly preventing depressurization**, so it was decided to **vent the containment vessel (abbreviated "vent/venting") first and then open the SR valve to depressurize the reactor and finally pump in seawater**.
- At around 16:00 **it appeared that it would be a while until opening the vent valve**, so **priority was changed to depressurizing the reactor using the SR valves**. The Station Director gave instructions to do this simultaneously with venting.
- With no electric power, batteries would be needed to open the SR valve. **Batteries were collected** from vehicles **and carried to the Main Control Room, and power cables were connected to the batteries, but the battery voltage was insufficient, so more batteries were added and attempts were made to open several SR valves** and other efforts continued to be made toward depressurizing the reactor, and at around 18:00 reactor depressurization started.
- High temperature and pressure in the S/C was non-conducive to condensation, and so it took time for the depressurization to come about.

  Reactor pressure: 6.998MPa (16:34) → 6.075MPa (18:03) → 0.63MPa (19:03)

[Restarting the fire engine]

- Radiation dose in the field was high, and thus faced with the necessity for personnel to take turns checking the operating status of the fire engine, at 19:20 it was discovered that the fire engine being used for pumping seawater had stopped due to running out of fuel. After refueling, **seawater injection into reactor began via fire trucks through fire protection system lines (one truck starts up at 19:54, the other at 19:57)**.

END

Fukushima Daiichi Nuclear Power Station Unit 2
Circumstances of Venting of Containment Vessel

This document is compilation of facts as they are known at the present time based on a variety of report and eye witness accounts. If and when new facts come to light hereafter as the investigation continues, they will be disclosed at that time.

◆ **Details of actions following "determination and notification of emergency core cooling system water injection malfunction at 16:36 on March 11"**

・ Having restored the instruments, the reactor water level was determined at 21:50 (Top of Active Fuel + 3,400 millimeters), and at 23:25 the drywell pressure was discerned (0.141MPa abs). Furthermore, **as RCIC was confirmed to be operating at 2:55 on March 12, venting of Unit 1 was given higher priority**. In addition to taking steps toward venting Unit 1, the monitoring of Unit 2 parameters continued.

◆ **Details of actions taken after "Directive given by Station Director to begin preparations for venting on March 12 at 17:30."**

[Preparation for venting]

・ As the injection of coolant into the reactor via RCIC continues, drywell pressure stabilizes at around 200～300kPa abs, but as it is expected that venting is eventually inevitable, preparations are started for vent lineup simultaneously with Unit 3. It is decided that since the radiation dose in the field is low, all the valves needed for venting except the rupture disk should be opened.

・ At 0:06 on March 12, the possibility of Unit 1 drywell pressure exceeding 600 kPa abs was recognized, so as specific preparations for venting were started, and while **referring to schematic diagrams of the valves, it was determined whether the valve needed for venting could be opened manually, and whether it could be forced open by attaching a jig.** Based on that outcome as well as the schematic diagrams of the piping, Accident Management procedure, and Unit 1 operation manual, the method of opening the valves needed for venting ((the primary containment vessel (PCV) vent valve (MO valve) was possible to open manually, but suppression chamber (S/C) vent valve (AO valve) could not be manually opened)) was checked, and the venting procedure was drawn up. Also, location of vent valves in the field were checked using a valve checksheet.

(Hereafter, March 13)

[Operation to open PCV vent valve (MO valve) and S/C large vent valve (AO valve)]

・ In order to perform manual opening of PCV vent valve (MO valve), **Shift Supervisor put**

on their self-contained breathing apparatus and other required equipment, and flashlights in hand, set out for the reactor building.

- **At 8:10, the PCV vent valve (MO valve) is opened 25% in accordance to the procedure.**
- 11:00 - The S/C large vent valve (AO valve) solenoid valve is opened by excitation via the small portable generator used for temporary lighting in the Main Control Room. Vent line configuration is completed except for rupture disk.

(Due to drywell pressure being below the rupture disk threshold pressure (427 kPa gage,) it did not vent at this moment. Vent valves are left open, and drywell pressure monitoring continues.)

◆ **Details of actions taken after "March 14 at 11:01 - The explosion of Unit 3 reactor building ... the coolant injection line for which preparations were completed became unusable due to damage to fire truck and hoses."**

[Effects of the explosion]

- **Due to the effects of the explosion, the S/C large vent valve (AO valve) solenoid valve excitation circuit were torn loose and the valve closed.** Vent lineup needed to be done over again.
- **After the explosion, all workers except for the Shift Supervisor in the Main Control Room stopped work and evacuated to the seismic-isolated building. Because the safety of workers had to be ascertained and field conditions had to be checked, restoration work could not be performed for a period of time.**
- **Drywell pressure became stable at around 450 kPa abs, below the venting pressure level.**

[Operation to open the S/C small vent valve (AO valve)]

- After the all-clear signal following the explosion and evacuation, at around 16:00, operation to open the S/C large vent valve (AO valve) was conducted, but at around 16:20, air from the air compressor was found to be insufficient to open the valves.
- No reduction of the drywell pressure could be seen, so at around 18:35, vent line restoration work was resumed on the S/C small vent valve (AO valve) as well as the S/C large vent valve (AO valve). It was presumed that the S/C large vent valve (AO valve) could not be opened due to solenoid valve failure.
- At around 21:00 the small S/C valve (AO valve) partially opened to a small degree, and the vent lineup was complete except for the rupture disk.

(Drywell pressure being below the rupture disk threshold (427 kPa gage), it did not vent at

this moment. Vent valves remained open, and drywell pressure monitoring continued.)

[Operation to open the small drywell vent valve]

- 22:50 - Drywell pressure is on the rise. Pressure exceeds maximum operating pressure 427 kPa gage, thus deemed to be an event "abnormal rise in containment vessel pressure" as specified in Article 15 of the Nuclear Disaster Law.
- Although drywell pressure was rising steadily, the S/C pressure was stable at around 300~400 kPa abs, **creating a condition of non-equalized pressure.** Due to the S/C pressure being below the rupture disk trigger threshold and drywell pressure being on the rise, it was decided to conduct venting by opening the small drywell vent valve (AO valve).
- March 15, 0:02 - The vent lineup was complete except for the rupture disk. A few minutes later the said valve was confirmed to be closed.

(Drywell pressure did not decrease below 750 kPa abs. Thereafter drywell pressure leveled off at a high level.)

◆ **Details of actions taken after "March 15, approximately 6:00 to 6:10, Loud impact sound emanates from around the area of the suppression chamber."**

- At around 6:00 to 6:10, a loud impact sound emanates from around the area of the suppression chamber. Suppression chamber pressure reading is 0 MPa abs.
- Personnel other than those essential personnel engaged in plant monitoring and emergency restoration work are temporarily evacuated to Fukushima Daini.
  - Personnel numbering 650 are evacuated to Fukushima Daini, leaving a task force of approximately 70 personnel.
- Shift Supervisor went to the Main Control Room once every several hours to collect data on the drywell pressure parameters, etc.
  - At around 11:25, drywell pressure was confirmed falling
    (730 kPa abs (at 7:20) → 155 kPa abs (at 11:25))

END

Chronology of Main Events at Fukushima Daiichi Nuclear Power Station Unit 3 from Impact of Earthquake through Tuesday, March 15

This document is compilation of facts as they are known at the present time based on a variety of report and eye witness accounts. If and when new facts come to light hereafter as the investigation continues, they will be disclosed at that time.

Friday, March 11, 2011

14:46	Tohoku-Chihou-Taiheiyo-Oki Earthquake strikes. Automatic proclamation of Level 3 State of Emergency.
14:47	Automatic reactor SCRAM and main turbine trip.
14:48(approx.)	Emergency diesel generator starts automatically.
14:54	Reactor subcriticality confirmed.
15:05	Reactor Core Isolation Cooling system (RCIC) started up manually.
15:06	Extraordinary Disaster Countermeasures Headquarters established at company Head Office (assess extent of earthquake damage, restore lost power).
15:25	RCIC trip (high reactor water level).
15:27	Arrival of the first tsunami wave.
15:35	Arrival of the second tsunami wave.
15:38	Total loss of AC power.
15:42	**A specified event (complete loss of AC power) in accordance with stipulations of Article 10, Paragraph 1 of the Nuclear Disaster Special Measures Law (hereafter abbreviated "Nuclear Disaster Law")was determined to have occurred, government and other authorities were notified.**
15:42	First state of emergency declared. Emergency Countermeasures Headquarters established (merged with Emergency Disaster Countermeasures Headquarters).
16:03	**RCIC started up manually.**
16:36	Second state of emergency declared.
20:50	Fukushima prefectural authorities issue evacuation directive to residents living within 2km radius of Fukushima Daiichi Nuclear Power Station.
21:23	Prime Minister issued directive for evacuation within 3km radius and take refuge indoors within 3km to 10km of Fukushima Daiichi Nuclear Power Station.
21:58	Temporary lighting lights up Main Control Room.

Saturday, March 12, 2011

0:30	Government confirms completion of measures for evacuating residents (confirmed measures for evacuating residents of Futaba-machi(town) and Ookuma-machi(town) within 3km, reconfirmed at 1:45).
4:55	Rise in radiation dose within power station grounds discovered (0.069 μ Sv/h(4:00) → 0.59 μ Sv/h(4:23) in area around main gate), government and other authorities notified.
5:44	Prime Minister issued directive for all residents within 10km radius from Fukushima Daiichi Nuclear Power Station to evacuate.
7:11	Prime Minister arrived at Fukushima Daiichi Nuclear Power Station.
8:04	Prime Minister departed from Fukushima Daiichi Nuclear Power Station.
11:36	**RCIC trip.**
12:35	**High Pressure Coolant Injection system (HPCI) starts up automatically (low reactor water level).**
17:30	**Preparations to vent pressure containment vessel (hereafter, "vent/venting") ordered by Station Director.**
18:25	Prime Minister issued directive for residents within 20km radius from Fukushima Nuclear Power Station to evacuate.

Sunday, March 13, 2011

2:42	**HPCI stops.**
5:10	Because the injection of coolant into the reactor via the RCIC could not be accomplished, a specified event (reactor cooling ability lost) in accordance with stipulations of the Nuclear Disaster Law Article 15 Paragraph 1 was determined to have occurred, and government and other authorities were notified at 5:58.
5:15	**Station Director issued directive to finish the vent lineup except for the rupture disk.**
5:50	Start of venting announced to press.
6:19	It is deemed that Top of Active Fuel (TAF) had been reached at 4:15, so government and other authorities were notified.
7:35	Estimation of radiation exposure as the result of venting notified to government and other authorities.
7:39	Containment spray commenced, government and other authorities were notified at 7:56.
8:35	Containment vessel (PCV) valve (MO valve) opened.

8:41 **Pressure Suppression Chamber (S/C) large vent valve (AO valve) opened, thereby completing configuration of vent line except rupture disk. Government and other authorities notified at 8:46.**

8:56 Radiation dose in excess of 500 μ Sv/h measured at monitoring post (measured value 882 μ Sv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of Nuclear Disaster Law was determined to have occurred, government and other authorities notified at 9:01.

9:08(approx.) Reactor pressure rapid depressurization implemented by means of safety-relief valve. Government and other authorities were notified at 9:20 that injection of coolant into reactor by means of fire protection system to be carried out hereafter.

9:25 Start of using fire-engines to inject fresh water into reactor via the fire protection system lines. (with boric acid)

9:36 **Drywell pressure confirmed to be falling at around 9:20 resulting from venting operation, and injection of coolant into reactor by way of fire protection system begun, and notification given to government and other authorities.**

10:30 **Station Director gave instructions to keep an eye on the possibility of seawater injection.**

11:17 S/C large vent valve (AO valve) confirmed shut. (cylinder for operating equipment low on pressure)

12:20 **Fresh water injection ends.**

12:30 S/C large vent valve (AO valve) opened. (cylinder for operating equipment changed)

13:12 **Pumping seawater into reactor via fire protection system lines using the fire trucks began.**

14:15 Radiation dose exceeding 500μSv/h detected at monitoring post (measured value 905μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of Nuclear Disaster Law was determined to have occurred, government and other authorities notified at 14:23.

Monday, March 14, 2011

1:10 Volume of remaining seawater being supplied to the reactor from the back wash pit running low, so fire engine halted so as to replenish seawater.

2:20 Radiation dose exceeding 500μSv/h detected at main gate (751μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of Nuclear Disaster Law was determined to have occurred, government and other authorities notified at 4:24.

2:40 Radiation dose exceeding 500μSv/h detected at monitoring post (650μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified at 5:37.

3:20 Restart of pumping seawater by fire truck.

4:00 Radiation dose exceeding 500μSv/h detected at monitoring post (820μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified at 8:00.

5:20 Start of S/C small vent valve (AO valve) opening operation.

6:10 Start of S/C small vent valve (AO valve) confirmed open.

9:12 Radiation dose exceeding 500μSv/h detected at monitoring post (518.7μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified at 9:34.

9:20 Start of replenishing seawater in back wash pit from the shallow draft quay.

11:01 Reactor building explodes. Fire truck and hoses damaged, seawater injection halted.

16:30(approx.) Fire truck and hoses replaced and new injection line configured from shallow draft quay to reactor, pumping of seawater restarted.

21:35 Radiation dose exceeding 500μSv/h detected at monitoring vehicle (760μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of Nuclear Disaster Law was determined to have occurred, government and other authorities were notified at 22:35.

Tuesday, March 15, 2011

6:50 Radiation dose exceeding 500μSv/h detected at area around main gate

(583.7μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of Nuclear Disaster Law was determined to have occurred, government and other authorities notified at 7:00.

7:00 Government and other authorities notified that personnel except those essential for monitoring and work operations are being temporarily evacuated to Fukushima Daini Power Station.

7:55 Steam seen wafting up from upper part of reactor building, government and other authorities notified.

8:11 Radiation dose exceeding of 500μSv/h detected at area around main gate (807μSv/h), thus a specified event (abnormal radioactive material emitted due to fire and explosion) in accordance with stipulations of Article 15 Paragraph 1 of Nuclear Disaster Law was determined to have occurred, government and other authorities were notified at 8:36.

11:00 Prime Minister issued directive for residents within 20 km to 30 km radius from Fukushima Nuclear Power Station to take refuge indoors.

16:00 Radiation dose exceeding 500μSv/h detected at main gate (531.6μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of Nuclear Disaster Law was determined to have occurred, government and other authorities were notified at 16:22.

23:05 Radiation dose exceeding 500μSv/h detected at main gate (4548μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of Nuclear Disaster Law was determined to have occurred, government and other authorities were notified at 23:20.

END

Fukushima Daiichi Nuclear Power Station Unit 3
State of Alternate Coolant Injection

This document is compilation of facts as they are known at the present time based on a variety of report and eye witness accounts. If and when new facts come to light hereafter as the investigation continues, they will be disclosed at that time.

◆ Details of actions taken after "March 12, 11:36 - RCIC stops"

[Using fire engines to inject coolant]

- The power station's fire engine was in use pumping seawater into Unit 1, so the request for assistance could not be met.
- After the tsunami struck, the roads were damaged and debris from the tsunami cut off the route connecting the Units 5 & 6 side, but the power station grounds roads were gradually restored by removing debris and placing sandbags to level the unevenness caused by cracks in the roads, so that passage to and from Units 5 & 6 was made possible, and the Units 5/6 side fire engine was brought in. In addition, one fire engine standing by at Fukushima Daini as emergency backup was brought to Fukushima Daiichi. Configuration of the coolant injection lineup using fresh water from fire protection cisterns was complete.
- In order to inject coolant using fire trucks, the safety-relief valves (SR valves) needed to be operated to depressurize the reactor, but batteries were in short supply, rendering the SR valves inoperable. By this time all available batteries on the premises had been collected and used for restoring power to Units 1 & 2 instruments and there were no spare batteries to be found, so the batteries were removed from the commuting vehicles used by Emergency Countermeasures Headquarters personnel and carried to the Main Control Room and connected to the instrument panel. Around 9:08, the SR valves were opened and rapid depressurization of the reactor was carried out.
- By rapidly depressurizing the reactor, the reactor pressure dropped to below the discharge pressure of the fire engine making the injection of coolant possible, so at 9:25 the use of the fire truck as the alternate method of injecting coolant began.

[Restoration of existing coolant injection system]

- Attempts were made to restart the existing coolant injection system, but to no avail.
  - Attempts were also made to inject coolant using the diesel-driven (D/D) fire protection pump, but reactor pressure had risen to around 4 MPa and injection was not possible.

- Attempts were also made to restart the HPCI, but batteries were exhausted and restarting failed.
- Attempts were also made to inject coolant into the reactor using the RCIC by going through the HPCI room to the RCIC room in order to check the conditions in the field, but it would not start up.

[Restoration of high pressure coolant injection systems]

- With the aim of restoring the standby liquid control system which is capable of injecting at high pressure, even as work was still continuing from the day before to restore power through the power center, the severe working environment (darkness, scattered obstacles, missing manhole covers in roads) and frequent work interruptions and taking refuge due to aftershocks prevented the work from progressing as expected, so restoration could not be completed.

◆ **Details of actions taken after "March 13, 10:30 - Station Director gives instructions to keep in mind the possibility of seawater injection."**

[Switchover to injecting seawater]

- Work begins at 12:20 for changing over the fresh water injection line from the nearby fire protection system cistern, which ran out of water, to the back wash valve pit containing seawater. Preparations had been made so that the switchover could be made in a short period of time, but an evacuation order was given while the work was being carried out due to an aftershock, so interruption of the work was unavoidable. Soon after the work resumed, the lineup was finished and injection of seawater started at 13:12.
- Arrangements were also being made for replenishing fresh water at the same time.

[Replenishing seawater in back wash valve pit]

- The requests continued to be made to all other stations for additional fire trucks, but because of issues such as radiation dose and contamination on the grounds and poor conditions of roads leading to the power station, the requested fire trucks from other stations could not proceed directly to the power station. The fire trucks had to be turned over to power station employees at the Off-site Center and J-Village and the like, and then continue onward to the power station from there, which delayed the arrival of the trucks.
- Seawater flooding the basement of the Unit 4 turbine was to be used as the water source, so the turbine building truck bay door shutter was broken down to allow the fire truck entry, and attempts were made to draw water, but did not succeed. In addition, Unit 4 discharge canal and Training Center pool and others were

considered for drawing water, but none materialized.

- March 14, 1:10 - With the remaining volume of seawater in the back wash valve pit running low, the fire engine is stopped in order to replenish the seawater in the pit. Seawater intake succeeds by adjusting the water intake position such as fire truck being moved closer to the back wash valve pit in order to place the intake hose deeper into the pit and such, and at 3:20 the injection of seawater into Unit 3 resumes.
- Additional fire trucks arrive at sunrise. A line is constructed, with two fire trucks deployed near the shallow draft quay taking seawater directly from the ocean and pumping it into the back wash valve pit. At 9:20, replenishing seawater in the back wash valve pit from the shallow draft quay begins.
- The seven 5-ton water supply trucks belonging to the Self Defence Forces requested for fresh water supply arrive. At 10:53, the trucks are deployed to the back wash valve pit for replenishing water in the pit. The work had already begun when the reactor building exploded and replenishing work was halted.

◆ **Details of actions taken after "March 14, 11:01 - Reactor building explodes. Fire truck and hoses damaged, seawater injection halted."**

Unit 3 after explosion

[State of damage]

- All workers except for the shift personnel in the Main Control Room stopped work and evacuated to the seismic-isolated building. Restoration work could not be started right away due to ascertaining safety of workers and checking the field conditions. Four TEPCO employees, three contractors, and four Self Defence force personnel were injured.
- The explosion scattered highly radioactive debris throughout the area. Fire truck and hoses are damaged, seawater injection halted. The back wash valve pit became unusable due to the rubble.

[Resumption of injecting coolant into reactor]

- Being unable to use the back wash valve pit, the undamaged fire truck was re-deployed to the shallow draft quay and hoses were re-laid so as to be able to draw seawater directly from the ocean for injection into the reactor. Connecting two fire trucks together in parallel, a line was configured for pumping seawater in the

direction of Units 2 & 3. At around 16:30, the fire trucks resume pumping seawater.

END

Fukushima Daiichi Power Station Unit 3
Circumstances of Venting of Containment Vessel

This document is compilation of facts as they are known at the present time based on a variety of report and eye witness accounts. If and when new facts come to light hereafter as the investigation continues, they will be disclosed at that time.

◆ **Details of actions taken after "March 12, 17:30 - Station Director gives instruction to prepare to start venting containment vessel."**

[Advance preparations for venting]

- **Discussions on procedure for venting begin** in Main Control Room **after 21:00**. **The sequence of valve operation and locations are investigated and written on whiteboard.**
- After completion of the Unit 1 venting procedures manual, the Emergency Countermeasures Headquarters Power Team and Restoration Team discuss the venting operation procedures manual while looking over the Unit 1 venting operation procedure manual and Unit 3 accident management procedures. The procedures decided on are notified to the Main Control Room.

(Hereafter, March 13)

- In order to open the S/C large vent valve (AO valve), forced excitation of the solenoid valve is carried out at around 4:50 making use of the small portable generator being used for temporary lighting in the Main Control Room. When the shift personnel went to the Torus chamber to check the open state of the valve, the indicator indicated closed, so it was presumed to be fully closed. Note that at the time, because of the high temperature reactor steam being discharged from the safety-relief valve into the S/C and because the temperature in the S/C at the bottom of the **Torus chamber** was rising, **the temperature inside the chamber was extremely hot, and with no lighting it was pitch dark**, making for a very severe working environment.

[Putting the finishing touches on the vent lineup]

- Around 5:15, the Station Director issues a directive to finish the vent lineup except for the rupture disk.
- Around 5:23, despite that the S/C large vent valve (AO valve) solenoid valve is being excited, the valve does not open, **so it is presumed that the cylinder needs to be replaced. The cylinder was then replaced, and the valve opened.**
- At 5:50, start of venting is announced to press.
- Around 8:35, vent valve (MO valve) is opened manually, and opens by 15% as according to plan.

◆ **Details of actions taken after "March 13, 8:41 - Pressure Suppression Chamber (S/C) vent valves (AO valves) large valves opened, thereby completing configuration of vent line except rupture disk."**

[Continuing to maintain the vent line]

- 8:41 - Vent lineup completed. Waiting for rupture disk to rupture.
- At 9:24, it is confirmed that drywell pressure is down from 0.637 MPa abs (at 9:10) to 0.540 MPa abs (at 9:24), so Emergency Headquarters determines that venting occured at around 9:20.
- At around 9:28, the cylinder installed on the S/C large vent valve (AO valve) air pressure is dropping, so personnel set out to tighten the cylinder connector. A leak is discovered, so repairs are made.
- 11:17 - the S/C large vent valve (AO valve) is confirmed shut due to cylinder leakage. The pneumatic drive cylinder is replaced, and opening operation performed. At 12:30 the S/C large vent valve (AO valve) is confirmed open.
- Personnel went to the Torus chamber to the lock the S/C large vent valve (AO valve) in open position, but due to the high temperature in the Torus chamber and vibrations from the operation of the Safety-relief valve, it could not be locked open.

[Rising radiation dose in the field]

- Around 14:31, it is reported that the **north side of the reactor building airlock is at least 300 mSv/h (and there is a white haze inside) and south side 100 mSv/h**. Furthermore, at 15:28 the **radiation dose inside the Unit 3 Main Control Room is 12 mSv/h**, so the shift personnel **take refuge by moving to the Unit 4 side Main Control Room**.
- At around 17:52, the temporary compressor replenishment operation is finished. Due to the high radiation dose, the Emergency Headquarters Restoration Team transports the temporary compressor to the turbine building truck bay door using the UNIC vehicle, and connects it to the IA line.
- Around 20:10- As the drywell is now depressurized, it is presumed that the S/C large vent valve (AO valve) is open.
- Thereafter, it was difficult to maintain an open state due to problems with S/C large vent valve (AO valve) pneumatic drive air pressure and maintaining excited state of the solenoid valve of the air supply line, opening operation had to be performed repeatedly.
  - 3/15 16:00 confirmed closed / 3/15 16:05 open operation performed
  - 3/17 21:00 confirmed closed / 3/17 21:30 (approx.) open operation performed
  - 3/18 5:30 confirmed closed / 3/18 5:30 (approx.) open operation performed
  - 3/19 11:30 confirmed closed / 3/20 11:25 (approx.) open operation performed

- 4/8　18:30 (approx.) confirmed closed

(Hereafter, March 14)

[Additional vent line]

- From approximately 2:00, drywell pressure starts building up※ thus the decision is made to open the S/C small vent valve (AO valve), and at around 3:40, forced excitation of the solenoid valve is carried out.

  ※0.265MPa abs (2:00) →0.315MPa abs (3:00)

- 5:20 - S/C small vent valve (AO valve) opening operation begins.　Later, it is confirmed open at 6:10.
- Thereafter, it was difficult to maintain an open state due to problems with S/C small vent valve (AO valve) pneumatic drive air pressure and maintaining excited state of the solenoid valve of the air supply line, opening operation had to be performed repeatedly.
  - 3/15　16:00confirmed closed / 3/16　1:55open operation performed
  - 4/8　18:30 (approx.) confirmed closed

END

Chronology of Main Events at Fukushima Daiichi Nuclear Power Station Unit 4 from Impact of Earthquake through Tuesday, March 15

This document is compilation of facts as they are known at the present time based on a variety of report and eye witness accounts. If and when new facts come to light hereafter as the investigation continues, they will be disclosed at that time.

- [Reference: State of Unit 4 at time of earthquake]Unit 4 had been stopped since November 30, 2010 for regular maintenance outage. Work was being done on the shroud, and therefore all fuel had been removed from the reactor and into the spent fuel pool.

Friday, March 11, 2011

14:46	**Tohoku-Chihou-Taiheiyo-Oki Earthquake Strikes.** Automatic proclamation of Level 3 State of Emergency.
15:06	Extraordinary Disaster Countermeasures Headquarters established at company Head Office (assess extent of earthquake damage, restore lost power)
15:27	Arrival of first tsunami wave.
15:35	**Arrival of second tsunami wave.**
15:38	Unit 4: Total loss of AC power.
15:42	A specified event (total loss of AC power) in accordance with stipulations of Article 10, Paragraph 1 of the Nuclear Disaster Special Measures Law (hereafter abbreviated "Nuclear Disaster Law") was determined to have occurred at Unit 1*, Unit 2*, Unit 3*, Unit 4*, Unit 5*, government and other authorities were notified. Later revised as being only Unit 1, Unit 2 and Unit 3, on April 24, 2011.
15:42	First state of emergency declared. Emergency Countermeasures Headquarters established (merged with Emergency Disaster Countermeasures Headquarters).
16:36	Second state of emergency declared.
20:50	Fukushima prefectural authorities issue evacuation directive to residents living within 2- km radius of Fukushima Daiichi Nuclear Power Station.
21:23	Prime Minister issued directive for evacuation within 3- km radius and take refuge indoors within 3- km to 10- km of Fukushima Daiichi Nuclear Power Station.

Saturday, March 12, 2011

0:30 Government confirms completion of measures for evacuating residents (confirmed measures for evacuating residents of Futaba-machi(town) and Ookuma-machi(town) within 3- km, reconfirmed at 1:45)

4:55 Confirmed that radiation dose had risen inside the power station grounds, government and other authorities notified.

5:44 Prime Minister issued directive for all residents within 10- km radius from Fukushima Daiichi Nuclear Power Station to evacuate.

7:11 Prime Minister arrived at Fukushima Daiichi Nuclear Power Station.

8:04 Prime Minister departed from Fukushima Daiichi Nuclear Power Station.

16:27 Radiation dose exceeding 500μSv/h detected at monitoring post (1,015μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Law was determined to have occurred, government and other authorities notified .

18:25 Prime Minister issues directive for residents within 20- km radius from Fukushima Nuclear Power Station to evacuate.

Sunday, March 13, 2011

8:56 Radiation dose exceeding 500μSv/h detected at monitoring post (882μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of Nuclear Disaster Law was determined to have occurred, government and other authorities notified at 9:01.

14:15 Radiation dose exceeding 500μSv/h detected at monitoring post (905μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of Nuclear Disaster Law was determined to have occurred, government and other authorities notified at 14:23.

Monday, March 14, 2011

2:20 Radiation dose exceeding 500 μ Sv/h detected at area around main gate (751 μ Sv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Law was determined to have occurred,

government and other authorities were notified at 4:24.2:40 Radiation dose exceeding 500μSv/h detected at monitoring post (650μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Law was determined to have occurred, government and other authorities were notified at 5:37.

4:00 Radiation dose exceeding 500μSv/h detected at monitoring post (820μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Law was determined to have occurred, government and other authorities were notified at 8:00.

4:08 Unit 4 spent fuel pool confirmed to be 84℃.

9:12 Radiation dose exceeding 500μSv/h detected at monitoring post (518.7μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Law was determined to have occurred, government and other authorities were notified at 9:34.

21:35 Radiation dose exceeding 500μSv/h detected at monitoring car (760μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Law was determined to have occurred, government and other authorities were notified at 22:35.

Tuesday, March 15, 2011

6:00～6:10 (approx.) There is a loud noise. Afterward, damage was seen in the vicinity of the 5th floor roof of the Unit 4 reactor building.

6:50 Radiation dose exceeding 500μSv/h detected at area around main gate 583.7μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Law was determined to have occurred, government and other authorities were notified at 7:00.

7:55 The discovery of damage in the vicinity of the 5th floor roof of the Unit 4 reactor building is notified to the government and other authorities.

8:11 Unit 4 reactor building checked for damage, radiation dose exceeding 500μSv/h detected at are around main gate (807μSv/h), thus a specified event (abnormal radioactive material emitted due to fire and explosion) in

accordance with stipulations of Article 15 Paragraph 1 of Nuclear Disaster Law was determined to have occurred, government and other authorities notified at 8:36. 9:38 Fire is found to have broken out in the vicinity of the 3rd floor northwest corner of the Unit 4 reactor building, government and other authorities notified at 9:56.

11:00 Prime Minister issues directive for residents within 20- km to 30- km radius from Fukushima Nuclear Power Station to take refuge indoors.

11:00 (approx.) When Tepco employees go into the field to check on the Unit 4 reactor building fire, the fire is confirmed to have gone out by itself, and this is notified to government and other authorities at 11:45.

16:00 Radiation dose exceeding 500 μ Sv/h detected at area around main gate 531.6 μ Sv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Law was determined to have occurred, government and other authorities were notified at 16:22.

23:05 Radiation dose exceeding 500 μ Sv/h detected at area around main gate 4548 μ Sv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Law was determined to have occurred, government and other authorities were notified at 23:20.

END

Chronology of Main Events at Fukushima Daiichi Nuclear Power Station Unit 5 from Impact of Earthquake through Reactor Cold Shutdown

This document is compilation of facts as they are known at the present time based on a variety of report and eye witness accounts. If and when new facts come to light hereafter as the investigation continues, they will be disclosed at that time.

[Reference: Status of Unit 5 when earthquake occurred]

- Unit 5 had been in outage and shut down since January 3, 2011. Tests were being conducted to check for leaks in the reactor pressure vessel in a state where fuel was loaded into the reactor.

(Reactor pressure was approximately 7MPa, reactor water temperature approximately 90℃, and the spent fuel pool temperature approximately 25℃)

Friday, March 11, 2011

14:46	**Great East Japan Earthquake strikes.** Automatic proclamation of Level 3 State of Emergency.
14:47	Automatic shutdown of main turbine, emergency Diesel Generators (DG) start up automatically.
15:06	Extraordinary Disaster Countermeasures Headquarters established at company Head Office (assess extent of earthquake damage, restore lost power)
15:27	Arrival of first tsunami wave.
15:35	**Arrival of second tsunami wave.**
15:40	**Total loss of AC power.**
15:42	A specified event (total loss of AC power) in accordance with stipulations of Article 10, Paragraph 1 of the Nuclear Disaster Special Measures Act (hereafter abbreviated "Nuclear Disaster Act") was determined to have occurred at Unit 1*, Unit 2*, Unit 3*, Unit 4*, Unit 5*, government and other authorities were notified. ※ Later revised as being only Unit 1, Unit 2 and Unit 3, on April 24, 2011.
15:42	First state of emergency declared. Emergency Countermeasures Headquarters established (merged with Emergency Disaster Countermeasures Headquarters).
16:36	Second state of emergency declared.
20:50	Fukushima prefectural authorities issued evacuation directive to residents

living within 2-km radius of Fukushima Daiichi Nuclear Power Station.

21:23 Prime Minister issued directive for evacuation within sphere of 3-km radius and take refuge indoors within the sphere of 3-km to 10-km distance from Fukushima Daiichi Nuclear Power Station.

Saturday, March 12, 2011

0:09 On account of the inspection being conducted of the station's internal power systems, departure made from the Unit 5 and Unit 6 sites.

0:30 Government confirms completion of measures for evacuating residents (confirmed measures for evacuating residents of Futaba-machi (town) and Ookuma-machi (town) within a 3-km radius, reconfirmed at 1:45)

1:40(approx.) Safety-relief valve ("SRV") automatically opened (thereafter, it is repeatedly opened and closed to maintain the reactor pressure at approximately 8MPa).

4:55 Rise in radiation dose within power station grounds discovered, government and other authorities notified.

5:44 Prime Minister issued directive for all residents within 10-km radius from Fukushima Daiichi Nuclear Power Station to evacuate.

6:06 The reactor pressure vessel depressurized by conducting an operation to open the top of the reactor pressure vessel.

7:11 Prime Minister arrived at Fukushima Daiichi Nuclear Power Station.

8:04 Prime Minister departed from Fukushima Daiichi Nuclear Power Station.

8:13 Power supply using existing cable from the Unit 6 DG to Unit 5 (part of the DC power supply) becomes feasible.

14:42 Using power supplied from the DG, the Unit 6-side air-conditioning system part of the emergency heating, ventilation and air-conditioning system for the Unit 5/6 main control room manually started and cleaning of the air inside the Unit 5/6 main control room commenced.

16:27 Radiation dose exceeding 500μSv/h detected at monitoring post (1,015μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified.

18:25 Prime Minister issued directive for residents within 20-km radius from Fukushima Nuclear Power Station to evacuate.

Sunday, March 13, 2011

8:56 Radiation dose exceeding 500μSv/h detected at monitoring post (882μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified at 9:01.

14:15 Radiation dose exceeding 500μSv/h detected at monitoring post (905μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified at 14:23.

18:29 Power started to be supplied using a temporary cable from the Unit 6 DG to the make-up water condensate system ("MUWC").

20:54 MUWC pumps manually started up.

21:01 The stand-by gas treatment system manually started.

Monday, March 14, 2011

2:20 Radiation dose exceeding 500μSv/h detected at area around main gate (751μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified at 4:24.

2:40 Radiation dose exceeding 500μSv/h detected at monitoring post (650μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified at 5:37.

4:00 Radiation dose exceeding 500μSv/h detected at monitoring post (820μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified at 8:00.

5:00 Operation conducted to open the SRV and depressurization implemented of the reactor pressure vessel (thereafter, operations are conducted intermittently to open the reactor pressure vessel).

5:30 Injection commenced of coolant into the reactor using MUWC

(thereafter, coolant injected intermittently).

9:12 Radiation dose exceeding 500μSv/h detected at monitoring post (518.7μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified at 9:34.

9:27 Replenishing the spent fuel pool with water commenced (thereafter, replenishment conducted intermittently).

21:35 Radiation dose exceeding 500μSv/h detected at monitoring car (760μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified at 22:35.

Tuesday, March 15, 2011

6:50 Radiation dose exceeding 500μSv/h detected at area around main gate 583.7μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified at 7:00.

11:00 Prime Minister issued directive for taking refuge indoors within the sphere of 20-km to 30-km distance from Fukushima Daiichi Nuclear Power Station.

16:00 Radiation dose exceeding 500μSv/h detected at main gate (531.6μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified at 16:22.

23:05 Radiation dose exceeding 500μSv/h detected at area around main gate (4548μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified at 23:20.

Wednesday, March 16, 2011

22:16 Replacement commenced of spent fuel pool water.

Thursday, March 17, 2011

5:43 **Replacement completed of spent fuel pool water.**

Friday, March 18, 2011

13:30 **Work completed on perforation of roof floor of reactor building (3 locations).**

Saturday, March 19, 2011

1:55 **Using the temporary power supply from power-generating vehicle, the residual heat removal system ("RHR") temporary seawater pumps started up.**

4:22 **Second Unit 6 DG unit started up.**

5:00(approx.) **RHR manually started up (spent fuel pool cooling commenced in emergency thermal load mode).**

8:58 Radiation dose exceeding 500μSv/h detected at area around west gate (830.8μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified at 9:15.

Sunday, March 13, 2011

10:49 **RHR manually shut down (emergency thermal load mode).**

12:25 **RHR manually started up (reactor cooling commenced in shutdown cooling mode).**

14:30 **Reactor water temperature fell below 100℃, and reactor cold shutdown was achieved.**

END

Chronology of Main Events at Fukushima Daiichi Nuclear Power Station Unit 6 from Impact of Earthquake through Reactor Cold Shutdown

This document is compilation of facts as they are known at the present time based on a variety of report and eye witness accounts. If and when new facts come to light hereafter as the investigation continues, they will be disclosed at that time.

[Reference: Status of Unit 6 when earthquake occurred]

- Unit 6 had been in outage and shut down since August 14, 2010. It was in long-term shutdown due to failure of the flammability control system. Fuel was loaded into the reactor which was in cold shutdown.

(Reactor pressure was approximately 0MPa, reactor water temperature approximately 25℃, and the spent fuel pool temperature approximately 25℃)

Friday, March 11, 2011

14:46	**Great East Japan Earthquake strikes.** Automatic proclamation of Level 3 State of Emergency.
14:47	Automatic shutdown of main turbine, 3 emergency Diesel Generators (DG) start up automatically.
15:06	Extraordinary Disaster Countermeasures Headquarters established at company Head Office (assess extent of earthquake damage, restore lost power)
15:27	Arrival of first tsunami wave.
15:35	**Arrival of second tsunami wave.**
15:36	**2 DGs were tripped.**
15:42	First state of emergency declared. Emergency Countermeasures Headquarters established (merged with Emergency Disaster Countermeasures Headquarters).
16:36	Second state of emergency declared.
20:50	Fukushima prefectural authorities issue evacuation directive to residents living within 2-km radius of Fukushima Daiichi Nuclear Power Station.
21:23	Prime Minister issued directive for evacuation within sphere of 3-km radius and take refuge indoors within the sphere of 3-km to 10-km distance from Fukushima Daiichi Nuclear Power Station.

Saturday, March 12, 2011

0:09 **On account of the inspection being conducted of the station's internal power systems, departure made from the Unit 5 and Unit 6 sites.**

0:30 Government confirms completion of measures for evacuating residents (confirmed measures for evacuating residents of Futaba-machi(town) and Ookuma-machi(town) within 3-km, reconfirmed at 1:45)

4:55 Rise in radiation dose within power station grounds discovered, government and other authorities notified.

5:44 Prime Minister issued directive for all residents within a sphere of 10-km radius from Fukushima Daiichi Nuclear Power Station to evacuate.

6:03 **Configuration of a line for supplying power within the station commenced from the Unit 6 DG.**

7:11 Prime Minister arrived at Fukushima Daiichi Nuclear Power Station.

8:04 Prime Minister departed from Fukushima Daiichi Nuclear Power Station.

8:13 **A power supply interchange using the main cable from the Unit 6 DG to Unit 5 (part of the DC power supply) is feasible.**

14:42 **Using power supplied from the DG, the Unit 6-side air-conditioning system part of the emergency heating, ventilation and air-conditioning system for the Unit 5/6 main control room manually started and cleaning of the air inside the Unit 5/6 main control room commenced.**

16:27 Radiation dose exceeding 500 μSv/h detected at monitoring post (1,015 μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified .

18:25 Prime Minister issued directive for residents within the sphere of 20-km from Fukushima Nuclear Power Station to evacuate.

Sunday, March 13, 2011

8:56 Radiation dose exceeding 500 μSv/h detected at monitoring post (882 μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified at 9:01.

13:01 **Make-up water condensate system (MUMC) pumps manually started up.**

13:20 **Using the power supply from DG, injection commenced of coolant into**

the reactor using MUWC (thereafter, coolant injected intermittently).

14:15 Radiation dose exceeding 500 μSv/h detected at monitoring post (905 μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified at 14:23.

18:29 Power started to be supplied using a temporary cable from the DG to the Unit 5 MUWC.

Monday, March 14, 2011

2:20 Radiation dose exceeding 500 μSv/h detected at area around main gate (751 μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified at 4:24.

2:40 Radiation dose exceeding 500 μSv/h detected at monitoring post (650 μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified at 5:37.

4:00 Radiation dose exceeding 500 μSv/h detected at monitoring post (820 μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified at 8:00.

9:12 Radiation dose exceeding 500 μSv/h detected at monitoring post (518.7 μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified at 9:34.

14:13 Replenishing the spent fuel pool with water commenced (thereafter, replenishment conducted intermittently).

21:35 Radiation dose exceeding 500 μSv/h detected at monitoring car (760 μSv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other

authorities were notified at 22:35.

Tuesday, March 15, 2011

6:50 Radiation dose exceeding 500 μ Sv/h detected at area around main gate 583.7 μ Sv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified at 7:00.

11:00 Prime Minister issued directive for taking refuge indoors within the sphere of 20-km to 30-km distance from Fukushima Daiichi Nuclear Power Station.

16:00 Radiation dose exceeding 500 μ Sv/h detected at area around main gate 531.6 μ Sv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified at 16:22.

23:05 Radiation dose exceeding 500 μ Sv/h detected at area around main gate 4548 μ Sv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government and other authorities were notified at 23:20.

Wednesday, March 16, 2011

13:10 Fuel pool cooling system ("FPC") manually started (circulating operation with no heat removal capacity).

Friday, March 18, 2011

17:00 Work completed on perforation of roof floor of reactor building (3 locations).

19:07 DG seawater pumps started up.

Saturday, March 19, 2011

4:22 Second DG started up.

8:58 Radiation dose exceeding 500 μ Sv/h detected at area around west gate 830.8 μ Sv/h), thus a specified event (abnormal rise in radiation dose at perimeter of station grounds) in accordance with stipulations of Article 15 Paragraph 1 of the Nuclear Disaster Act was determined to have occurred, government

and other authorities were notified at 9:15.

21:26 **Using the temporary power supply from power-generating vehicle, the residual heat removal system ("RHR") temporary seawater pumps started up.**

22:14 **RHR manually started up (spent fuel pool cooling commenced in emergency thermal load mode).**

Sunday, March 20, 2011

16:26 **RHR manually shut down (emergency thermal load mode).**

18:48 **RHR manually started up (reactor cooling commenced in shutdown cooling mode).**

19:27 **Reactor water temperature fell below 100℃, and a cold shutdown of the reactor was performed.**

END

Fukushima Daiichi Nuclear Power Station Unit5/6
The Response Situation Through Reactor Cold Shutdown

This document is compilation of facts as they are known at the present time based on a variety of report and eye witness accounts. If and when new facts come to light hereafter as the investigation continues, they will be disclosed at that time.

○Activities from the Earthquake Occurrence at 14:46 until First Tsunami Wave Arrived at 15:27 on March 11th

- See "Response Immediately After Disaster Struck at Fukushima Daiichi Nuclear Power Station"

○ Activities from Determination and Notification of Station Blackout at 15:42 on March 11th Through Cold Shutdown on March 20th (at 14:30 for Unit 5 and at 19:27 for Unit 6)

[State of Unit 5/6 Main Control Room]

- See "Response Immediately After Disaster Struck at Fukushima Daiichi Nuclear Power Station"
- **Because one unit (6B) of the Unit 6 emergency diesel generators ("DG") was not affected by the tsunami and maintained operability and the high-voltage electric panels (M/C) in the reactor complex building were usable, the supply of power was maintained to part of the emergency equipment (B system) even after the tsunami arrived at Unit 6.**
- **At Unit 6, because of the fact that power supply to lighting and monitoring instruments was secured, the parameters of the reactor and spent fuel pool could be verified.**
- Meanwhile, on the Unit 5 side, emergency lights gradually went out, reaching a state of total darkness, but some of the monitoring instruments were operating on DC power supply even after the station blackout, **and the indicated values necessary for conducting Unit 5 recovery operations could be verified.**
- **At 14:42 on March 12th, one unit of the emergency heating, ventilation and**

Unit 5/6 main control room: Unit 6 side

Unit 5/6 main control room: Unit 5 side (Lighting only from emergency lights)

air-conditioning system was manually started using power supplied from the Unit 6 DG. As a result of this, an environment was maintained where full-face masks did not need to be worn inside the main control room.

- It is noted that early recovery of an external power source was difficult, that power continued to be supplied by only one Unit 6 DG unit, and that there were concerns about insufficient fuel (depletion). Consequently, fuel oil (diesel fuel) was provided. From the Kanto region beginning on March 18th, **tank lorries transported diesel fuel to the nuclear power station daily to continue replenishing the Unit 6 diesel fuel tank and ensure fuel for the DG**. **It is also noted that company employees carried out the tank lorry transport to the power station within the area directed for evacuation (currently, the closed area) and replenished the diesel fuel tanks** (up to 20 round trips were carried out per day).

[Power Supply Interchange from Unit 6 to Unit 5]

- **In the Unit 5 building where the lights had gone out and which was in a state of total darkness, operators held flashlights to verify the inundation condition of the electric panel room and the usability of the electric panels.** It was confirmed that all of the Unit 5 high-voltage electric panels (M/C) were unusable.
- Because the continuous operation of the DG ensured the capacity for an internal power source for Unit 6, **a cable, which had been laid for interchanging power between adjacent plants, was used as an accident management measure between Unit 6 and Unit 5** to interchange power to Unit 5 at 8:13 on March 12th. As a result of this, power was able to be supplied to some of the DC-powered equipment (A systems) in Unit 5.
- In addition, by laying temporary power cable directly from the instrumentation electric panels in the Unit 6 service building to the instrumentation electric panels in the Unit 5 control building, power could be supplied to the Unit 5 monitoring instruments in the main control room that operate on AC power supply.
- Later, because power could not be supplied to the Unit 5 low-voltage electric panels (MCC) due to submersion of the Unit 5 high-voltage electric panels (M/C), a temporary power cable was begun to be laid directly from the low-voltage electric panels (MCC) in the Unit 6 turbine building to the equipment necessary for recovery operations for Unit 5. **The Unit 5 stand-by gas treatment system was started up at 21:01 on March 13th (the Unit 6 stand-by gas treatment system continued to operate after the earthquake). As a result of this, the Unit 5 and Unit 6 reactor buildings maintained negative pressure thereafter, and a state was maintained in which the release of radioactive materials, if there were such a contingent event, would be checked.**

[Operation to Depressurize the Unit 5 Reactor Pressure Vessel]

- When the earthquake occurred, Unit 5 was in outage and being tested for leaks in the reactor pressure vessel, and the reactor water level was at the high-water level and pressurized to approximately 7MPa.
- After the earthquake, the reactor pressure slowly rose due to decay heat, so the operators attempted a depressurization operation using successively the reactor core isolation cooling system steam line, high pressure coolant injection system (HPCI) steam line, and HPCI exhaust line, but the reactor pressure did not change.
- Even after that, the pressure rose. However, because pressure was maintained at approximately 8MPa, it was determined that the SRV would automatically operate to open. It is noted that there was no power source for indicator lights in the main control room and the situation was one where the operational status of the SRV could not verified by indicator lights, but because of the operation of an air supply line for the valve on the top of the reactor pressure vessel, which will be discussed later, **an operator heading toward the site confirmed the sound of the SRV operating inside the reactor building.**
- By manually operating on site the valves inside the reactor building to lower the reactor pressure, a line was configured to supply air to open the valve on top of the reactor pressure vessel, and, at 6:06 on March 12th, an operation to open the valve on the top of the reactor pressure vessel was performed in the main control room. As a result of this, **the reactor pressure was able to be brought down to the atmospheric level.**
- Later, the reactor pressure once again rose due to decay heat, so beginning before dawn on March 14th, recovery work on the SRV was commenced (because of the tests being conducted for leaks, the SRV was set so that it could not be operated from the main control room). The electric fuses were restored and the valves on the nitrogen gas supply line, which is inside the primary containment vessel, were operated manually on site to complete configuration of a line, and the SRV was set so that it could be operated from the main control room. **At 5:00 on March 14th, an operation was performed to open the SRV and depressurization of the reactor pressure vessel was commenced.**

[Alternative Coolant Injection into the Unit 5 and Unit 6 Reactors]

- After the soundness of the Unit 5 condensate water transfer pump was verified by the recovery team on March 13th, a temporary electric supply cable was laid directly from the Unit 6 low-voltage electric panels (MCC), and the power supply was able to be restored at 18:29, so after depressurization of the reactor by means of the SRV, **at 5:30 on March 14th, the injection of coolant into the reactor was commenced by using an alternative**

coolant injection line, which connected the fire protection system line and the residual heat removal system line and was used as an accident management measure.

- The Unit 6 condensate water transfer pump was in an operable condition due to the supply of power from the Unit 6 DG, and **at 13:20 on March 13th, the injection of coolant into the reactor was commenced utilizing the line being used for accident management.**

[Curbing Rise in Temperature of the Unit 5 and Unit 6 Spent Fuel Pool]

- All of the Unit 5 and Unit 6 seawater pumps were unusable due to the impact of the tsunami, and the spent fuel pool where the spent fuel was stored could not be cooled.
- After assessing the rate of the rise in temperature with regard to the decay heat in the spent fuel pool, the spent fuel pool water temperature continued to be monitored until heat removal capability was restored.
- The Unit 5 and Unit 6 condensate water transfer pump was restored, so **on March 14th, the line used for accident management was utilized to replenish the water in the spent fuel pool until it was almost at the high level.**
- Later, on March 16th to check the rate at which the temperature of the spent fuel pool was rising until the heat removal capacity was restored, **after draining some of the spent fuel pool water the temperature of which had risen at Unit 5, the line used for accident management was utilized to replenish the water by means of the condensate water transfer pump.**
- Power was able to be supplied to the Unit 6 FPC pump from the Unit 6 DG, so on March 16th, the FPC pump was started up in a circulating operation (no heat removal capacity), and the water of the spent fuel pool was agitated to curb the rate at which the temperature of the spent fuel pool was rising.

[Restoration of Unit 5 and Unit 6 RHR Heat Removal Capacity]

- Due to the outage, approximately 2.5 months had passed since Unit 5 had been shut down and approximately 7 months since Unit 6 had been shut down, and **the decay heat inside the reactor at the time of the earthquake was comparatively less than when the plant is operating.**
- As a result of verifying the soundness of the Unit 5 and Unit 6 RHR seawater pumps, the recovery team determined that the pumps could not be used. In cooperation with the Head Office, consideration

Work conditions for installation of underwater pump

began to be given to **connecting general service underwater pumps to a seawater system pipe temporarily for restoration as an RHR alternative cooling seawater pump.**

Underwater pump installation conditions (arrangement done at later date)

- Starting on March 17th, work was commenced to remove debris from the area around where the underwater pump was to be installed and work was undertaken to prepare a work road. On March 18th, a temporary power supply cable was laid from a high-voltage power generating vehicle and the installation of the outdoor pump operation panel was completed, so **the temporary RHR seawater pumps were started up and restored for Unit 5 at 1:55 and for Unit 6 at 21:26 on March 19th.**
- Because the permanent power supply for the Unit 5 RHR pump was in operable due to the Unit 5 high-voltage electric panels (M/C) in the underground level of the turbine building having been inundated by the tsunami, **on March 18th, approximately 200 meters of temporary power supply cable was laid from the Unit 6 high-voltage electric panels (M/C) to supply power directly to the Unit 5 RHR pump.**
- It is noted that **for the Unit 6 RHR pump, there was a high-voltage electric panel (M/C) load from the Unit 6 DG, and power was able to be supplied.**
- As a result of the restoration of the RHR pump and the RHR seawater pump, the heat removal capacity of one system for Unit 5 and Unit 6 was usable, so it was decided to **alternate between cooling the reactor and the spent fuel pool by switching the system configuration of the RHR.**
- After the temperature of the spent fuel pool water decreased, the RHR system configuration was switched and moved to cooling the reactor. **The reactor water temperature fell below 100℃ and a cold shutdown of the reactor was achieved (at 14:30 for Unit 5 and at 19:27 for Unit 6 on March 20th).**
- It is noted that at Unit 5, the FPC pump was started up at 16:35 on June 24th, with the spent fuel pool being cooled by the same pump and the reactor being cooled by the RHR.

[Preventing Retention of Hydrogen Gas in Unit 5 and Unit 6 Reactor Buildings]

- Since the earthquake occurred, the water levels of the reactor and the spent fuel pool were maintained and conditions were not such that hydrogen gas would build up. However, because there was also the risk that coolant injection capacity and heat removal

Work conditions on the roof

capacity might be lost due to aftershocks, as a precaution, it was decided **to examine measures for preventing the retention of hydrogen gas. On March 18th, a boring machine was used to drill holes at three locations (diameter ranging from approximately 3.5 centimeters to approximately 7 centimeters) on the roof (concrete) of the Unit 5 and Unit 6 reactor buildings.**

- The work was commenced early in the morning on March 18th. Four station employees and four contractor personnel **equipped themselves with full-face masks, charcoal filters, and coveralls, went up onto the roof of the reactor building, and performed the work for approximately 11 hours total for both Unit 5 and Unit 6** (work was completed at 13:30 on Unit 5 and at 17:00 on Unit 6).

[Restoration of Unit 6 Emergency Diesel Generator]

- **With regard to the seawater pump for cooling the Unit 6 DG (6A), although it had been covered with seawater in the tsunami, operators and recovery teams conducted a visual inspection of the inundation situation of the outdoor seawater pump area, the external condition of the damage and other such conditions, and carried out measurements of insulation resistance and other functions** to verify soundness, and it was started up at 19:07 on March 18th.

Condition of seawater pump area
(indicates the DG (6A) seawater pump)

- At 4:22 on March 19th, the Unit 6 DG (6A) was started up, ensuring that two DG units would be used as emergency power sources for Unit 5 and Unit 6.

END