Chronology of Main Events at Fukushima Daini Nuclear Power Station Unit 1 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.

Friday, March 11, 2011

14:46	**Tohoku-Chihou-Taiheiyo-Oki Earthquake strikes.** Automatic proclamation of Level 3 State of Emergency.
14:48	**Automatic reactor SCRAM**
14:48	One of the Tomioka lines shuts down (power continues to be received from another line).
15:00	Reactor subcriticality confirmed.
15:06	Extraordinary Disaster Countermeasures Headquarters established at company Head Office (assess extent of earthquake damage, restore lost power)
15:22	**First tsunami wave confirmed (thereafter, tsunami waves are confirmed until 17:14).**
15:33	Circulating water pump ("CWP") (C) manually shut down.
15:34	Emergency diesel generators (A) (B) (H) automatically started up/immediately thereafter, they were shut down due to the tsunami impact.
15:36	Main steam isolation valve fully closed manually.
15:36	Reactor core isolation cooling system ("RCIC") manually started up (thereafter, starts-stops occur as the circumstances demand).
15:50	Iwaido line is fully shut down.
15:55	Depressurization of reactor commenced (safety relief valve opened) (thereafter, valve is repeatedly opened and closed to control reactor pressure).
15:57	CWP (A) (B) automatically shut down.
17:35	**Given the fact that a "high drywell pressure" alert was issued and that the alarm typer recorded "MSIV reactor water level low (L-2)," the possibility of a reactor coolant leak inside the primary containment vessel ("PCV") cannot be denied as being the cause of the pressure rise, thus a specified event (reactor coolant leak) 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 at 17:50. (Subsequently, with confirmation of the relevant parameters, a leakage of reactor coolant was not verified. Therefore, at around 18:33 on the same day, it was determined that the event in question did not fall within such purview.).

17:53 Drywell cooling system manually started up.

18:33 Because startup of a sea water pump for equipment having the capability to remove heat from the reactor could not be confirmed, a specified event (loss of reactor heat removal capability) in accordance with stipulations of Article 10 Paragraph 1 of Nuclear Disaster Law was determined to have occurred, government and other authorities were notified at 18:49.

Saturday, March 12, 2011

0:00 Alternative coolant injection is commenced using the make-up water condensate system ("MUWC")

3:50 Rapid depressurization of the reactor is commenced.

4:56 Rapid depressurization of the reactor is concluded.

4:58 RCIC manually shut down.

5:22 Because the pressure suppression chamber ("S/C") temperature had risen to over 100℃, specified event (loss of pressure suppression capability) 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 5:48

6:20 S/C cooling implemented using coolant (MUWC) from the flammability control system ("FCS").

7:10 Drywell spraying implemented using MUWC (thereafter, implemented as circumstances demand).

7:37 S/C spraying implemented using MUWC (thereafter, implemented as circumstances demand).

7:45 Prime Minister issued directive for evacuation within 3-km radius and take refuge indoors within the 10-km radius from Fukushima Daini Nuclear Power Station.

7:45 S/C cooling using FCS coolant (MUWC) is shut down.

10:21 Configuration of a PCV hardened venting line commenced.

13:38 (approx.) Power received through one Iwaido line.

14:05 Government confirms completion of measures for evacuating residents (confirmed measures for evacuating residents of Naraha-machi (town) and

Tomioka-machi (town) within 3 km).

17:39 Prime Minister issued directive for evacuation within 10-km radius from Fukushima Daini Nuclear Power Station.

18:30 Configuration of the PCV hardened venting line completed.

Sunday, March 13, 2011

5:15 (approx.) Power received through second Iwaido line.

20:17 Residual heat removal equipment cooling seawater system pump (B) manually started up.

21:03 Residual heat removal equipment cooling system pump (D) manually started up.

Monday, March 14, 2011)

1:24 Residual heat removal system ("RHR") (B) manually started up (S/C cooling mode commenced), thus a specified event (loss of reactor heat removal capability) in accordance with the stipulations of Article 10 Paragraph 1 of the Nuclear Disaster Law was determined to be rescinded.

1:44 Emergency auxiliary cooling system pump (B) manually started up.

3:39 RHR (B) S/C spray mode commenced.

10:05 In the RHR (B) low-pressure coolant injection mode, coolant is injected into the reactor.

10:15 Because the pressure suppression chamber ("S/C") temperature had fallen below 100℃, it was determined that the plant recovered from a specified event (loss of pressure suppression capability) in accordance with stipulations of Article 15 Paragraph 1 of Nuclear Disaster Law, government and other authorities were notified at 10:35

17:00 Reactor water temperature fell below 100℃, and cold shutdown of the reactor was achieved.

End

Chronology of Main Events at Fukushima Daini Nuclear Power Station Unit 2 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.

Friday, March 11, 2011

14:46	**Tohoku-Chihou-Taiheiyo-Oki Earthquake strikes.** Automatic proclamation of Level 3 State of Emergency.
14:48	**Automatic reactor SCRAM**
14:48	One of the Tomioka lines shuts down (power continues to be received from another line).
15:01	Reactor subcriticality confirmed.
15:06	Extraordinary Disaster Countermeasures Headquarters established at company Head Office (assess extent of earthquake damage, restore lost power)
15:22	**First tsunami wave confirmed (thereafter, tsunami waves were confirmed until 17:14).**
15:34	Emergency diesel generator ("DG") (H) automatically started up/immediately thereafter, it was shut down due to the tsunami impact.
15:34	Main steam isolation valve fully closed manually.
15:35	Residual heat removal system ("RHR") (B) manually started up (shuts down automatically at 15:38).
15:35	Circulating water pump ("CWP") (C) manually shut down and CWP (A) (B) automatically shut down.
15:41	DG (A) (B) automatically started up/immediately thereafter, they were shut down due to the tsunami impact.
15:41	Depressurization of reactor commenced (safety relief valve opened) (thereafter, valve is repeatedly opened and closed to control reactor pressure).
15:43	Reactor core isolation cooling system ("RCIC") manually started up (thereafter, starts-stops occur as the circumstances demand).
15:50	Iwaido line was fully shut down.
18:33	**Because startup of a sea water pump for equipment having the capability to remove heat from the reactor could not be confirmed, specified event (loss of reactor heat removal capability) in accordance with stipulations of Article 10 Paragraph 1 of Nuclear Disaster Law was determined to**

have occurred, government and other authorities were notified at 18:49

20:02 Drywell cooling system manually started up.

Saturday, March 12, 2011

4:50 **Alternative coolant injection is commenced using the make-up water condensate system ("MUWC").**

4:53 RCIC automatically shuts down.

5:32 **Because the pressure suppression chamber temperature has risen to over 100℃, specified event (loss of pressure suppression capability) 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 5:48**

6:30 Suppression chamber ("S/C") cooling implemented using coolant (make-up water purified system ("MUWP")) from the flammability control system ("FCS").

7:11 Drywell spraying implemented using MUWC (thereafter, implemented as circumstances demand).

7:35 S/C spraying implemented using MUWC (thereafter, implemented as circumstances demand).

7:45 Prime Minister issued directive for evacuation within 3-km radius and take refuge indoors within the 10-km radius from Fukushima Daini Nuclear Power Station.

7:52 S/C cooling using FCS coolant (MUWP) is shut down.

10:33 Configuration of a primary containment vessel ("PCV") hardened venting line commenced.

10:58 Configuration of the PCV hardened venting line completed.

13:38 (approx.) Power received through one Iwaido line.

14:05 Government confirms completion of measures for evacuating residents (confirmed measures for evacuating residents of Naraha-machi(town) and Tomioka-machi(town)within 3-km).

17:39 Prime Minister issued directive for evacuation within 10-km radius from Fukushima Daini Nuclear Power Station.

Sunday, March 13, 2011

5:15 (approx.) Power received through second Iwaido line.

Monday, March 14, 2011

3:20	Emergency auxiliary cooling system (B) manually started up.
3:51	Residual heat removal equipment cooling seawater system pump (B) manually started up.
5:52	Residual heat removal equipment cooling system pump (D) manually started up.
7:13	**RHR (B) manually started up (S/C cooling mode commenced), thus a specified event (loss of reactor heat removal capability) in accordance with the stipulations of Article 10 Paragraph 1 of the Nuclear Disaster Law was determined to be rescinded.**
7:50	RHR (B) S/C spray mode commenced.
10:48	In the RHR (B) low-pressure coolant injection mode, coolant was started to be injected into the reactor.
15:52	**Because the pressure suppression chamber temperature has fallen below 100℃, it was determined that the plant recovered from a specified event (loss of pressure suppression capability) in accordance with stipulations of Article 15 Paragraph 1 of Nuclear Disaster Law, government and other authorities were notified at 16:15.**
18:00	**Reactor water temperature fell below 100℃, and cold shutdown of the reactor was achieved.**

End

Chronology of Main Events at Fukushima Daini Nuclear Power Station Unit 3 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.

Friday, March 11, 2011

14:46	**Tohoku-Chihou-Taiheiyo-Oki Earthquake strikes.** Automatic proclamation of Level 3 State of Emergency.
14:48	**Automatic reactor SCRAM**
14:48	One of the Tomioka lines shuts down (power continues to be received from another line).
15:05	Reactor subcriticality confirmed.
15:06	Extraordinary Disaster Countermeasures Headquarters established at company Head Office (assess extent of earthquake damage, restore lost power)
15:22	**First tsunami wave confirmed (thereafter, tsunami waves are confirmed until 17:14).**
15:34	Circulating water pump ("CWP") (C) manually shut down.
15:35	Emergency diesel generators ("DG") (A) (B) (H) automatically started up/immediately thereafter, DG (A) shuts down due to the tsunami impact.
15:36	Residual heat removal system ("RHR") (B) manually started up (suppression chamber ("S/C") cooling mode commenced).
15:37	Main steam isolation valve fully closed manually.
15:38	CWP (B) manually shut down.
15:46	Depressurization of reactor commenced (safety relief valve opened) (thereafter, valve is repeatedly opened and closed to control reactor pressure).
16:06	Reactor core isolation cooling system ("RCIC") manually started up (thereafter, starts-stops occur as the circumstances demand).
16:48	CWP (A) automatically shut down.
20:12	Drywell cooling system manually started up.
22:53	**Alternative coolant injection is commenced using the make-up water condensate system ("MUWC")**
23:11	RCIC manually shut down.

Saturday, March 12, 2011

0:06	Preparations commenced for configuration of RHR (B) reactor shutdown cooling system (“SHC”) mode.
1:23	RHR (B) manually shut down (in preparation for SHC mode).
2:39	RHR (B) manually shut down (S/C cooling mode commenced).
2:41	RHR (B) S/C spray mode commenced.
7:45	Prime Minister issued directive for evacuation within 3-km radius and take refuge indoors within 10-km radius from Fukushima Daini Nuclear Power Station.
7:59	RHR (B) manually shut down (S/C cooling mode and S/C spray mode shut down).
9:37	RHR (B) manually shut down (operation of SHC mode commenced).
12:08	Configuration of a primary containment vessel (“PCV”) hardened venting line commenced.
12:13	Configuration of a PCV hardened venting line completed.
12:15	**Reactor water temperature fell below 100℃, and cold shutdown of the reactor was achieved.**

End

Chronology of Main Events at Fukushima Daini Nuclear Power Station Unit 4 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.

Friday, March 11, 2011

14:46	**Tohoku-Chihou-Taiheiyo-Oki Earthquake strikes.** Automatic proclamation of Level 3 State of Emergency.
14:48	**Automatic reactor SCRAM**
14:48	One of the Tomioka lines shuts down (power continues to be received from another line).
15:05	Reactor subcriticality confirmed.
15:06	Extraordinary Disaster Countermeasures Headquarters established at company Head Office (assess extent of earthquake damage, restore lost power)
15:22	**First tsunami wave confirmed (thereafter, tsunami waves are confirmed until 17:14).**
15:33	Circulating water pump ("CWP") (C) manually shut down.
15:34 (approx.)	Emergency diesel generators ("DG") (A) (B) (H) automatically started up/immediately thereafter, DG (A) and (B) were shut down due to the tsunami impact.
15:35	CWP (A) and (B) automatically shut down.
15:36	Main steam isolation valve fully closed manually.
15:36	Residual heat removal system ("RHR") (B) manually started up (it automatically shut down at 15:41).
15:37	RHR (A) manually started up (it was manually shut down at 15:38).
15:46	Depressurization of reactor commenced (safety relief valve opened) (thereafter, valve is repeatedly opened and closed to control reactor pressure).
15:50	Iwaido line was fully shut down.
15:54	RCIC manually started up (thereafter, starts-stops occur as the circumstances demand).
18:33	**Because startup of a sea water pump for equipment having the capability to remove heat from the reactor could not be confirmed, a specified event (loss of reactor heat removal capability) 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 at 18:49.

19:14 Drywell cooling system manually started up.

Saturday, March 12, 2011

0:16 RCIC automatically shuts down. Alternative coolant injection was commenced using the make-up water condensate system ("MUWC").

6:07 Because the pressure suppression chamber temperature had risen to over 100℃, specified event (loss of pressure suppression capability) 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 6:18.

7:23 Suppression chamber ("S/C") cooling implemented using coolant (make-up water purified system ("MUWP")) from the flammability control system ("FCS").

7:35 S/C spraying implemented using MUWC.

7:45 Prime Minister issued directive for evacuation within 3-km radius and take refuge indoors within 10-km radius from Fukushima Daini Nuclear Power Station.

11:17 Reactor coolant injection switched from MUWC (alternative coolant injection) to high-pressure core spray system ("HPCS").

11:44 Configuration of a primary containment vessel ("PCV") hardened venting line commenced.

11:52 Configuration of the PCV hardened venting line completed.

13:38 (approx.) Power received through one Iwaido line.

13:48 Reactor coolant injection using HPCS shut down (thereafter, implemented as circumstances demand)

14:05 State confirms that evacuation measures have been completed for the evacuation of residents (confirmation that measures have been completed for evacuation of an area within 3km from the towns of Naraha and Tomioka).

17:39 Prime Minister issued directive for evacuation within 10-km radius from Fukushima Daini Nuclear Power Station.

Sunday, March 13, 2011

5:15 (approx.) Power received through second Iwaido line.

Monday, March 14, 2011

11:00 Emergency auxiliary cooling system (B) manually started up.

13:07 Residual heat removal equipment cooling seawater system pump (D) manually started up

14:56 Residual heat removal equipment cooling system pump (B) manually started up

15:42 RHR (B) manually started up (S/C cooling mode commenced), thus a specified event (loss of reactor heat removal capability) in accordance with the stipulations of Article 10 Paragraph 1 of the Nuclear Disaster Law was determined to be rescinded.

16:02 RHR (B) S/C spray mode commenced.

18:58 In the RHR (B) low-pressure coolant injection mode, coolant is injected into the reactor (it is shut down at 19:20) (thereafter, starts-stops are implemented as the circumstances demand).

22:07 Because the radiation dose measured exceeds 5 μGy/h at a monitoring post (No. 1), **a specified event (increase in radiation dose at site boundary) in accordance with stipulations of Article 10 Paragraph 1 of Nuclear Disaster Law was determined to have occurred, government and other authorities were notified at 22:13** (the cause of the dose increase is surmised to be due to the effects of radioactive material released into the atmosphere following the accident at Fukushima Daiichi Nuclear Power Station).

Tuesday, March 15, 2011

0:12 Because the radiation dose measured exceeds 5 μGy/h at a monitoring post (No. 3), **a specified event (increase in radiation dose at site boundary) in accordance with stipulations of Article 10 Paragraph 1 of Nuclear Disaster Law was determined to have occurred, government and other authorities were notified at 0:16** (the cause of the dose increase is surmised to be due to the effects of radioactive material released into the atmosphere following the accident at Fukushima Daiichi Nuclear Power Station).

7:15 Because the pressure suppression chamber temperature has fallen below 100℃, it is determined that a recovery has been achieved from the conditions of the specific event (loss of pressure suppression capability) in accordance with stipulations of the provision of Paragraph 1 of Article 15

of Nuclear Disaster Law, government and other authorities were notified at 7:35.

7:15 **Reactor water temperature fell below 100℃, and cold shutdown of the reactor was achieved.**

End

Fukushima Daini Nuclear Power Station
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 Confirmed at 15:22 on March 11th

[Ascertaining of safety and evacuation]

- At the main administrative building, personnel evacuated to the parking area, which was the evacuation site, and safety was confirmed. Subsequently, the personnel required for countermeasures moved to the seismic-isolated building and began to initiate the response. Other station personnel evacuated to the outside arena.

[Scram Response Operation]

- The earthquake occurred. Because tremors were severe, operators grabbed handrails in front of the control panels, squatted down and waited. The Shift Supervisor gave advance warning of the scram operation, and instructed the operators to wait for the tremors to subside and then commence the scram response operation.
- The Assistant Shift Supervisor made it known that an earthquake had occurred and gave instructions to evacuate over the general paging system. Site operators were contacted by PHS and instructed to evacuate.
- At 14:48, each of the main control rooms also confirmed that there had been automatic reactor scrams. Thereafter, it was also confirmed that the reactors were subcritical.
- The Shift Supervisor determined that, in addition to many alarms being issued, the sound from the fire alarm was loud and that the operators were not able to hear the instructions, and he took command by using the handheld microphone, which was kept behind the shift supervisor's chair for emergency use. (The fire alarm was later determined to be a false alarm.)
- The Shift Supervisor, who was informed by the power station emergency countermeasures headquarters ("power station countermeasures headquarters") that a warning had been issued for a great tsunami, gave instructions over the general paging system for an emergency evacuation pursuant to the giant tsunami warning.

[External Power Situation]

- The external power supply facility is comprised of four lines (two Tomioka lines and two Iwaido lines), and prior to the earthquake occurring, it was constituted by three lines, excepting the one Iwaido line which had been shut down for inspection.

- After the earthquake occurred, one Tomioka line was tripped, and one Iwaido line shut down due to an equipment failure at the Shin-Fukushima substation; however, external power continued to be available through the other Tomioka line.
- At 13:38 on March 12th and 5:15 on March 13th respectively, one line was restored on each day for the Iwaido line, and the external power supply configuration attained a three-line configuration (the remaining one Tomioka line was restored and power received on April 15th).

◆ Activities from Confirmation of the First Tsunami Wave at 15:22 Through Reactor Cold Shutdown

[Response Operation Immediately After Tsunami Struck]

- In the main control room for Units 1 and 2, it was confirmed with the site surveillance camera that the tsunami approached the seawall, and, in the main control room for Units 3 and 4, it was confirmed that the circulating water pump ("CWP") was half submerged.
- After the tsunami, the lights for all or a portion of the alarms on the control panels of the main control room of each unit were extinguished, and the situation was one where the lights repeatedly went on and off, but **approximately half of the lamp displays and instruments for verifying the operational state of the equipment and monitoring parameters at Unit 1 and all of the lamp displays and instruments at Units 2, 3 and 4 were secured, so it was possible to monitor the condition of the plant.**

Main control room immediately after tsunami

- The Shift Supervisor continuously monitored mainly the control panels of the reactor systems, and, taking into consideration the impact of the tsunami, gave instructions so that operators were positioned at control panels and conveyed information as the circumstances demanded so that the operational state of important seawater system facilities could be verified in order to implement heat removal from the reactors.
- In each of the main control rooms, with regard to the important seawater system facilities for removing heat from the reactors, it was confirmed, by lamp displays indicating operating/shutdown, that the pumps, which had been operating, were shut down.

Seawater pump that had been deluged with water (photo taken at a later date)

・ For each reactor, CWPs were shut down in accordance with the procedures for response operation when a tsunami occurs. Incidental to this, the main steam could no longer be condensed in the condenser, so the main steam isolation valve (“MSIV”) was closed completely, and the pressure control of the reactor was commenced by means of the main steam safety relief valve (“SRV”) and the injection of coolant into the reactor by means of the reactor core isolation cooling system (“RCIC”).

[Response Operation Through Reactor Cold Shutdown]

< Alternative Coolant Injection Using MUWC >

Valve operation at main control room AM panel (photo of work conditions at a later date)

・ The RHR, which has the primary function of injecting coolant to cool the reactor, could not be start up due to the impact of the tsunami, so, in preparation for cooling and injecting coolant to cool the reactor after the RCIC shut down along with the reactors, **preparations were commenced for alternative coolant injection using the make-up water condensate system (“MUWC”) which was introduced as an accident management (“AM”) measure. At Units 2, 3 and 4, the line was configured and the flow rate confirmed by means of a valve operation from the AM panel in the main control room. With regard to Unit 1, power had been lost due to the impact of the tsunami for the valves necessary for configuring the line, so the opening operation was implemented manually on site. After the line configuration was finished, the coolant injection valve was set to open and the flow rate confirmed from the main control room.**

・ Subsequently, following a decrease in reactor pressure, the RCIC shut down, but the reactor water level could be maintained without problem by means of alternative coolant injection using MUWC.

・ With regard to Unit 4, the high-pressure core spray system (“HPCS”) was started up on March 12th, and the injection of coolant into the reactor was switched from MUWC to HPCS. Subsequently, the reactor water level was controlled while repeatedly starting up and shutting down the HPCS.

< PCV Pressure Rise Control Measures >

・ At Units 1, 2 and 4, some of the seawater pumps were disabled due to the effect of the heat exchanger building (“Hx/B”) having been inundated by the tsunami, and the situation was such that the suppression chamber (“S/C”) could not be cooled. The temperature and pressure of the S/C rose due to the injection of coolant into the reactor by means of the RCIC and the decrease in reactor pressure by means of the SRV, and the power station

countermeasures headquarters examined means and methods for cooling the S/C. In accordance with advice from the power station countermeasures headquarters, the Shift Supervisor instructed the operators to utilize the drainage line to S/C from the cooler on the flammability control system ("FCS") to implement cooling of the S/C by means of the MUWC or make-up water purified system ("MUWP"). Subsequently, the implementation was carried out from units where preparations had been readied.

- **Alternative coolant injection into the reactor using MUWC was switched as circumstances required to the drywell ("D/W") spray and S/C spray in an effort to control the rise in PCV pressure.**
- In the main control room for Units 1 and 2, an effect of suppressing a rise in PCV pressure was expected and the D/W cooler (without a cooling source) was manually started up. Immediately after startup, the D/W temperature fell, so the information was provided to the Shift Supervisor at Units 3 and 4. The Shift Supervisor at Units 3 and 4 imitated this to conduct a similar response and confirmed that the D/W temperature decreased.

< PCV Hardened Venting Preparation >

- At the power station countermeasures headquarters, **reactor water level, D/W pressure and other plant parameters were able to be obtained at all times through communication (PHS) with the main control room, so it could be ascertained that the PCV pressure was tending to rise. At Units 1, 2 and 4, there was anticipation that it would take time to restore the reactor heat removal capability, and it was decided to undertake configuration of a line for PCV hardened venting (a situation in which one action remained for an operation to open the outlet valve on the S/C side).** Even at Unit 3, it was decided to configure a line for PCV hardened venting similar to the other units in preparation should PCV pressure rise.
- **At Units 2, 3 and 4, configuration of the line in question was completed in 5~25 minutes through the operation of switches in the main control room. On the other hand, at Unit 1, because the solenoid valve for drive air control for the hardened venting line inlet valve (air-operated valve) lost power due to the impact of the tsunami, the opening operation could not be performed.** As a result, the power station countermeasures headquarters examined countermeasures (a method for connecting a small compressed-gas cylinder to the valve driver and a method for restoring the power source of the solenoid valve in question and performing the opening operation), and **taking into account the trend of the PCV pressure rise, it was determined that there was a margin of time until the completion of the preparations for hardened venting, and it was decided to restore the power source of the solenoid valve in question and perform the opening operation.** Beginning at 16:00 on March 12th, confirmation was undertaken of the

power source route and configuration of an electric circuit was completed. At 18:30, the operation to open the hardened venting line inlet valve was performed. It was confirmed to be "open," and **configuration of the PCV pressure venting line was completed.**

< Ensuring Reactor Heat Removal Capability >

- At approximately 20:00 on March 11th, the power station countermeasures headquarters gave instructions to confirm the soundness of equipment while giving sufficient consideration to safety, and the operators and the restoration team at the power station countermeasures headquarters commenced confirmation of the site. From the condition of equipment and the state of inundation of power sources, the power station countermeasures headquarters determined the target equipment to be prioritized for inspection and repair of seawater system facilities important for removing heat from the reactor at each unit.
- **Temporary cable needed for restoration of the power supply was transported by helicopter from outside the power station.** Hurriedly, it was decided that the outside arena and baseball field would serve as the heliport. Early in the morning on March 12th, preparations were put in place, including throughout the night, for receiving the load, such as removing the fence around the outside arena and positioning 20 of the employees' vehicles to be used as guide lights for the helicopter to land. In addition, trucks even transported temporary cable with the roads in poor condition due to the impact of the earthquake.
- In order to restore power to the necessary equipment, temporary cable was laid from the radwaste building ("RW building") to the Hx/B for Units 1 and 2, and from the Hx/B for Unit 3 to the Hx/B for Units 2 and 4, and, moreover, from a high-voltage power supply vehicle through a power transformer temporarily set up at the entrance for large deliveries to the Unit 3 turbine building to the Hx/B for Units 1 and 4. The priority for restoration of the power supply was determined by assessing the condition of the plant from the change in D/W pressure and other parameters for each unit. The result was that although it was initially decided to respond by prioritizing Unit 2 and cable was started to be laid, subsequently, based on an assessment of changes in parameter movements, the order was changed to prioritize Unit 1.

Preparations for laying temporary cable (photo of work conditions at a later date)

- **In laying the temporary cable, a team was formed which was a mix of approximately 40 personnel from each of the respective Distribution Departments assembled from station personnel and each of the company offices (station employees and contractors),**

and the team performed the work while aftershocks were still occurring and with debris scattered about due to the impact of the tsunami. There was also night work depending on the Unit, and the work was undertaken while depending on vehicle headlights due to the total darkness.

- The temporary cable having a thickness of 2~3 centimeters was wound into one strand of three cables, and a length of approximately 200 meters weighed over one ton. **From the RW building to the Hx/B, it was necessary to lay the distance with a maximum length of approximately 800 meters. The work of laying the cable, which ordinarily would use machinery and take a considerable number of days was undertaken at a rapid pace using human power, and the total length of approximately 9 kilometers of temporary cable to be laid was partially carried out on March 12th and the majority of the work done and completed on March 13th.**
- **As for part of the seawater system facility important for conducting heat removal of the reactor at Unit 1, although the motor was cleaned, the insulation resistance was not restored, so a motor was brought from Mie Prefecture by a Self Defense Forces transport plane.** After the motor arrived at the power station, it was immediately mounted and a connection started with the temporary cable, and the work was finished by the evening of March 13th.
- With regard to the motor for part of the seawater system facility important from conducting heat removal of the reactor at Unit 4, the insulation resistance was not restored, so the motor was disassembled and inspected and, along with this, preparations were made for its replacement. From the results of the disassembly and inspection, it was determined that the existing motor could not be used, so **it was decided to use a motor transported by land from the Kashiwazaki-Kariwa Nuclear Power Station. During transport of the motor, the door of the Unit 4 Hx/B did not open, so the work of delivering the motor was difficult with the door having to be destroyed along with other problems.**

Pump motor recovery work
(photo of work conditions at a later date)

- At Units 1, 2 and 4, the seawater system facilities important for removing heat from the reactor and for which restoration had been completed were started up in sequence, and then, the RHR pump, which was sound, was started up. With this, it was determined that a recovery had been made from the event in question pursuant to Article 10 of the ASMNE (loss of reactor heat removal capability).

- Furthermore, by using the recovered reactor heat removal capability to conduct S/C cooling, the S/C temperature fell below 100°C, so it was determined that a recovery had been made from the conditions of the specific event (loss of pressure suppression capability) pursuant to the provision of Paragraph 1 of Article 15 of the ASMNE. Subsequently, coolant was injected into the reactor and the reactor water temperature fell below 100°C, so it was confirmed that cold shutdown had been achieved.
- With regard to Unit 3, the reactor was cooled by means of the RHR which had been confirmed to be sound and not affected by the tsunami. On March 12th, the reactor water temperature fell below 100°C, and cold shutdown was achieved.

End