Attachment 2

List of Documents concerning the Response Status at Fukushima Daiichi Nuclear Power Station and Fukushima Daini Nuclear Power Station (June 2012 version)

Fukushima Daiichi Nuclear Power Station

- ○ Response status at Fukushima Daiichi Nuclear Power Station Immediately after the Disaster
- ○ Response status Concerning Restoration of Power at Fukushima Daiichi Nuclear Power Station
- ○ Timeline of major events at Fukushima Daiichi Nuclear Power Station Unit 1 from the occurrence of the earthquake until March 12 (Sat.)
    - Response status concerning Fukushima Daiichi Nuclear Power Station Unit 1 cooling water injection
    - Response status concerning Fukushima Daiichi Nuclear Power Station Unit 1 PCV venting operation
- ○ Timeline of major events at Fukushima Daiichi Nuclear Power Station Unit 2 from the occurrence of the earthquake until March 15 (Tue.)
    - Response status concerning Fukushima Daiichi Nuclear Power Station Unit 2 cooling water injection
    - Response status concerning Fukushima Daiichi Nuclear Power Station Unit 2 PCV venting operation
- ○ Timeline of major events at Fukushima Daiichi Nuclear Power Station Unit 3 from the occurrence of the earthquake until March 15 (Tue.)
    - Response status concerning Fukushima Daiichi Nuclear Power Station Unit 3 cooling water injection
    - Response status concerning Fukushima Daiichi Nuclear Power Station Unit 3 PCV venting operation
- ○ Timeline of major events at Fukushima Daiichi Nuclear Power Station Unit 4 from the occurrence of the earthquake until March 15 (Tue.)
- ○ Timeline of major events at Fukushima Daiichi Nuclear Power Station Unit 5 from the occurrence of the earthquake until Reactor Cold Shutdown
- ○ Timeline of major events at Fukushima Daiichi Nuclear Power Station Unit 6 from the occurrence of the earthquake until Reactor Cold Shutdown
- ○ Response status at Fukushima Daiichi Nuclear Power Station until Reactor Cold Shutdown of Units 5 and 6

Fukushima Daini Nuclear Power Station

- ○ Timeline of major events at Fukushima Daini Nuclear Power Station Unit 1 from the occurrence of the earthquake until reactor cold shutdown
- ○ Timeline of major events at Fukushima Daini Nuclear Power Station Unit 2 from the occurrence of the earthquake until reactor cold shutdown
- ○ Timeline of major events at Fukushima Daini Nuclear Power Station Unit 3 from the occurrence of the earthquake until reactor cold shutdown
- ○ Timeline of major events at Fukushima Daini Nuclear Power Station Unit 4 from the occurrence of the earthquake until reactor cold shutdown
    - Response status at Fukushima Daini Nuclear Power Station until reactor cold shutdown

- ○ Attachment: Voices from the Field

Please refer to the following documents publicly disclosed by TEPCO for more information on plant data and records concerning the accidents at Fukushima Daiichi Nuclear Power Station and Fukushima Daini Nuclear Power Station.

Fukushima Daiichi Nuclear Power Station:
"Instruction to Report of the Operation Track Record Concernin the Accident of Fukushima Daiichi Nuclear Power Station and of the Accident Track Record of the Nuclear Reactor Facilities, etc." (Disclosed on April 26 and May 16, 2011)
"Submission of a Report on the Operation of the Plant Based on the Plant Data etc. of Fukushima Daiichi Nuclear Power Station at the time of the earthquake to Nuclear and Industrial Safety Agency, Ministry of Economy, Trade, and Industry" (Disclosed May 24, 2011)
Fukushima Daini Nuclear Power Station:
"Plant Date etc of Fukushima Daini Nuclear Power Station at the Time of the Occurrence of Tohoku-Chihou-Taiheiyo-Oki Earthquake" (Disclosed August 10, 2011)

End

These materials provide a summary of the facts as organized by TEPCO based on records, such as shift supervisor logs, operation logs and charts, various types of information, such as white boards in the MCR, and the results of interviews with related parties obtained through the course of the accident investigation.

Response status at Fukushima Daiichi Nuclear Power Station Immediately after the Disaster

○Actions taken from "March 11 14:46 Tohoku-Chihou-Taiheiyo-Oki Earthquake occurred" until "March 11 15:27 First tsunami wave arrival"

[Conditions prior to the earthquake]

- The skies around the power station were cloudy and the site superintendent was in his office preparing for a meeting at 15:00. Work in the main building and in the field was proceeding as normal with employees engaged in work in the field and at their desks.
- Units 1 to 3 were in operation and Units 4 to 6 were undergoing periodic inspection. Much work in the field was being conducted with the core shroud being replaced at Unit 4 and Unit 5 reactor pressure vessel (RPV) undergoing a pressure resistance leakage test. There were approximately 750 employees and approximately 5,600 contractors for total of approximately 6,400 people working at the power station on that day.

[Earthquake Occurs]

State of the Main Office

- At 14:46 on March 11, the earthquake occurred. The shaking became more and more violent. In the main building, each department managers ordered their staff to take cover under their desks. Employees protected themselves by putting on helmets used when working in the field.
- Disaster prevention department managers and members headed to the emergency broadcast room during the shaking in order to give an evacuation order but the broadcast facility was rendered inoperable by the earthquake. Members therefore ran around giving the order using megaphones.
- The shaking continued for a long time. Ceiling panels fell, bookshelves toppled scattering items all over the floor, desks moved

and some people even became trapped underneath their desks. Once the shaking had stopped people who were trapped were freed and employees moved to the parking lot next to the seismic isolated building which is a designated evacuation location. An evacuation drill had been performed approximately a week prior so everyone was aware of the evacuation routes and location.

- In the site superintendent's office, as items on book shelves were scattered about the room, the site superintendent grabbed onto both ends of the desk and waited until the shaking stopped. After the shaking stopped he put on a helmet and left the room. The superintendent ordered a large group of people that had gathered near the main entrance of the main building to evacuate to the seismic isolated building, told all groups to account for their numbers, and ordered all workers to evacuate.
- In the parking lot in front of the seismic isolated building, group members started to be accounted for. Employees who are designated as emergency disaster countermeasure personnel entered the seismic isolated building and began responding to the situation.

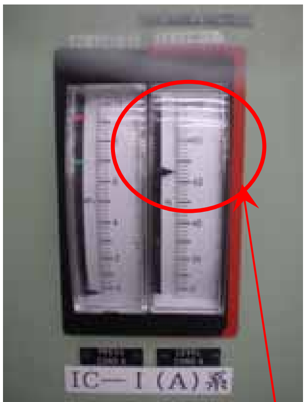
<Conditions in the Unit 1 and 2 Main Control Room (MCR)>

- When the earthquake occurred, 14 shift members and 10 work management group members, for a total of 24 operators, were working in the Unit 1 and 2 MCR.
- Operators waited until the shaking stopped and then initiated normal scram procedures. Operators used the PA to convey information about the earthquake, tsunami, and evacuation to Unit 1 and 2 work areas.

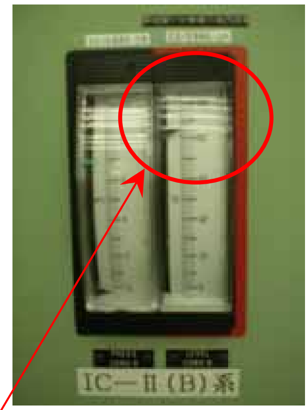
Unit 1 and 2 Main Control Room
(photo taken afterwards)

- The shift supervisor confirmed that the reactors had scrammed and then took command between the Unit 1 and Unit 2 panels. Operators in front of control panels monitored status and took action in accordance with the chief engineer's directions. The chief engineer reported on plant status and operation status to the shift supervisor. Operators confirmed that there was a loss of external power, that the emergency diesel generators (D/G) had activated, and that emergency bus power had been recharged.

- Operators monitoring parameters in front of the Unit 1 control panels confirmed that reactor pressure was dropping. Since reactor pressure was dropping regardless of the fact that the main steam isolation valve (MSIV) was closed, other operators were asked to ascertain the cause of the reactor pressure decrease at which time it was reported that the isolation condenser system (IC) secondary system had started up (automatic startup at 14:52). In the MCR, the sound of steam generation caused by IC startup was confirmed.
- Since the Unit 1 reactor pressure drop was quick it was assumed impossible to abide by the reactor coolant temperature change rate of 55°C/hr as stipulated in the operating procedures[1], so at 15:03 the IC return piping containment isolation valves (MO-3A, 3B) were fully closed and other valves left open with the system in normal standby. Since reactor pressure stopped decreasing it was assumed that the reactor pressure decrease was caused by startup of the IC and that there were no abnormalities with reactor isolation status. Since reactor water level was being maintained it was decided to control reactor pressure using the IC. It was deemed that one IC system would be suitable for controlling reactor pressure between approximately 6~7MPa, so it was decided that subsystem-A



IC(A) Steam Pressure Gauge, Water Level Indicator
(Photographed in the days after the accident)



IC(B) Steam Pressure Gauge, Water Level Indicator
(Photographed in the days after the accident)

The water level of IC(A), which was controlling reactor pressure, was lower than that of IC(B) (normally IC water level is approximately 80%). After arrival of the tsunami indicators were not visible due to loss of power.

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1 In a boiling water reactor (BWR) reactor core pressure is saturated and changes in the temperature of reactor coolant can be confirmed by changes in reactor pressure.

would be used and operators began controlling reactor pressure by opening and closing return piping containment isolation valves (MO-3A).

- No alarms that indicate abnormalities with emergency core standby cooling systems (CSC), such as the high-pressure cooling injection system (HPCI), for both Units 1 and 2 were confirmed, and indicator lights were normal.
- A Unit 1 operator thought to operate the HPCI with a test line[2] until it became necessary to inject cooling water into the reactor and configure the aforementioned line, however reactor water level was stable and reactor pressure was being controlled using the IC, so the aforementioned line was returned to normal. It was confirmed that the HPCI was capable of automatic startup so operators turned their attention to other operations and monitoring. Furthermore, the PCV cooling system secondary system was started up at 15:07 and 15:10 in preparation of activating the HPCI and safety relief valves (SRV), and cooling of the suppression chamber (S/C) commenced.
- In order to secure reactor water level Unit 2, operators manually started up the reactor core isolation cooling system (RCIC) at 14:50. At 14:51 it was confirmed that reactor water level was high due to the injection of cooling water into the reactor and that the RCIC had automatically shut down. Thereafter at 15:02 the RCIC was manually started and automatically shut down at 15:28 when the reactor water level was once again high. At 15:39 the RCIC was once again manually started. Furthermore, as with Unit 1 at 15:07 the residual heat removal system (RHR) primary system was started up and cooling of the S/C commenced.[3]
- Since it was reported that there were no problems with parameters the shift supervisor was “confident that it will be possible to control the situation (achieve cold shutdown) with conditions the way they were”.

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[2] Line where water taken from the condensate storage tank (CST) is looped back into the CST.

[3] According to the temperature event recorder the pressure vessel cooling system pump B system was started at around 15:05 and at around 15:11 the pressure vessel cooling system pump A system was started.

<Conditions in the Unit 3 and 4 Main Control Room >

- When the earthquake occurred, there were 9 shift members, 8 work management group members, and 12 outage team members for a total of 29 operators in the Unit 3 and 4 MCR.
- The earthquake caused the MCR to be filled with a white cloud of dust amidst which operators waited for the shaking to subside and then initiated normal scram procedures. It was reported to the shift supervisor that the reactors have been scrambled and it was confirmed that there was a loss of external power, that the D/G had activated and that the emergency bus power had been recharged.
- After the earthquake operators used the PA system to announce to all points on site information about the earthquake, tsunami, and evacuation. Furthermore the shift supervisor ordered that operator safety be confirmed.
- At 15:05 Unit 3 operators manually started the RCIC in order to secure reactor water level. At 15:25 reactor water level was high as a result of injecting cooling water into the reactor and the RCIC automatically shut down.
- Since word had been received that a tsunami was approaching operators headed to the sea side service building in order to give the evacuation order, and ordered three workers in the building to evacuate. Far off in the distance a white wave could be seen from the windows as the tsunami approached. Operators called out in the building to confirm that no one was left and then quickly hurried outside at which point they saw a column of water more than 10m high (as measured with the eye) rise just beyond the road back to the MCR. After freezing from fear for a second, the operators ran towards the rising column of water and returned to the MCR.

<Conditions in the Unit 5 and 6 Main Control Room >

- When the earthquake occurred there were 9 shift members, 8 work management group members, and 27 outage team members for a total of 44 operators in the Unit 5 and 6 MCR.
- While watching the panels at his own station, the shift supervisor protected himself and waited for the shaking to stop. Other operators protected themselves by crouching down, etc., and paid attention to

the racks and panel displays. After the shaking had subsided operators confirmed alarms of which almost all had gone off. It was confirmed that there is an extra loss of power, that the D/G had started up and that the emergency bus power had been recharged.

- After the earthquake the PA system and PHS wireless phones were used to convey information to the field about the earthquake, tsunami, and evacuation. Operators gathered in the field waiting room and then headed to the MCR.
- Attempts were made to monitor the tsunami using ITV but it was inoperable.

[Conditions at the power station emergency response center (ERC)]

- After everyone was accounted for in the parking lot in front of the seismic isolated building, employees that were designated as emergency disaster response personnel entered the seismic isolated building and began responding in accordance with their role in each functional team.
- The power generation team confirmed the status of each plant following the earthquake. It was reported by the MCR that the scramming of Units 1 to 3 had been successful and that the reactors had stopped. Thereafter word was received that off-site power had been lost and that the D/G had started up automatically. Word was also received that the Unit 1 IC had started up and that the RCIC was injecting cooling water into Unit 2 and Unit 3.

[Status of evacuation in the field]

- Out of the approximate 6,400 people working at the power station, approximately 2,400 workers were in controlled areas when the earthquake occurred.
- After the earthquake the area around the exit monitor gate at the exit of controlled areas in the service building was flooded with evacuating workers. Radiation control officers in the service building received instructions by telephone from the safety team to have workers evacuate from controlled areas without going through body surveys in accordance with the procedures created by lessons learned from the Niigata-Chuetsu-Oki Earthquake. Radiation control

officers opened the exit monitor gate and the control area entrance side door in order to create evacuation routes from the controlled areas and conducted the evacuation of a large number of workers. While continuous announcements were being made about the earthquake, tsunami, and evacuation, instructions were given to gather in front of the seismic isolated building which is on the high ground and had been designated in advance as an evacuation area.

- Evacuating workers flooded from the buildings, which are protected areas, to the area near the exit gate and waited to exit. It was assumed that if this situation persisted that workers would start to fall like dominoes and hinder quick movement through the gate. Employees that were providing security for protected areas convey the situation to the physical protection group manager. They received instructions to "prioritize saving lives and open the exit gate", after which security personnel in cooperation with contracted security personnel open the building gates and the surrounding vehicle gates in order to allow workers to evacuate quickly. Employees guided evacuees from the field and then evacuated themselves after confirming that all persons have been evacuated. The gates however were left open just in case someone had been left behind.
- Radiation control officers that had been conducting the evacuation at the Unit 3 and 4 service building headed to the MCR after everyone had been evacuated and reported to the shift supervisor that evacuation had been completed and that they themselves were going to evacuate to the seismic isolated building. Thereafter upon heading up the hill to the seismic isolated building they looked behind and witnessed that the tsunami arriving and heavy fuel oil tanks being swept away.
- In the port, heavy fuel oil tanks were in the process of being refueled from tanker ships, but the work was terminated and workers had evacuated. In preparation for the incoming tsunami, the tanker ship had moved off the coast and escaped danger.

<u>Details of actions taken after "March 11 15:42 Determining and notifying station black out"</u>

[Tsunami arrival]

- The first tsunami wave arrived at 15:27 and the second arrived at 15:35. The sound of the tsunami waves could not be heard from the MCR, seismic isolated building, or parking lot that was designated as an evacuation area. The power station ERC received word from the MCR that the D/G had stopped. Thereafter, team leaders were informed by the MCR that water had reached the entrance to the service building. Since the entrance to the service building is 10m above sea level and it was assumed that seawater would never reach it, and the power generation team leader was confused and repeatedly asked, "The entrance to what?" Gradually everyone in the power station ERC became aware of the tsunami arrival.

Tsunami Spray of approximately 50m

- Operators and security personnel that were conducting evacuations near the Unit 5 and 6 physical protection gate looked to the ocean after the last person had evacuated from the field to see the seawater recede exposing a seabed they had never seen before. When monitoring the ocean after seeking high ground, they saw a wall of water heading for the power station. The tsunami destroyed the seawall and pushed in near to the intake pump. The intake pump was then engulfed by the wave that followed. Heavy fuel tanks were destroyed, and heavy oil spilled into the ocean. The side of the suppression pool water surge tank was dented inwards and deformed and cars parked on the sea side were engulfed by the wave. A heavy fuel oil tank that had been swept away by the tsunami was seen floating out at sea.
- At 15:42 on March 11, the government was notified as the event was deemed to conform to Clause 10 Incident: Station Black Out (SBO) of the Act on Special Measures Concerning Nuclear Emergency Preparedness (Nuclear Emergency Act).
- At 16:36 on March 11, Clause 15 Incident: Core Cooling System

Cooling Water Injection Failure" of the Nuclear Emergency Act was deemed to apply since Unit 1 and 2 reactor water level could not be confirmed and the status of cooling water injection was unclear. Government agencies were notified at 16:45.

Tsunami destroys 10m high seawall and pushes inland

Units 1 to 4 flooded by tsunami

Tank deformed by the tsunami (Same tank shown in picture above)

Conditions on sea side after tsunami arrival

[Conditions in the main control room]

<Unit 1 and 2 Main Control Room >

- At 15:34 on March 11, as scram procedures and alarms caused by the earthquake were being handled gradually and the situation was becoming more under control, the Unit 2 "SW (auxiliary cooling seawater system) tunnel duct sump level high" alarm sounded in the MCR. Then, at 15:37 the "RVP (reversing valve pit) sump level high" alarm sounded as the Unit 1 D/G tripped simultaneously. An operator yelled, "SBO!". Power related condition indicator lamps blinked and then went out. Alarm indicator lamps and condition indicator lamps went out and it became impossible to read instruments. Operators tried to check instruments but they went out one by one until ultimately lighting on the Unit 1 side of the MCR consisted of emergency lights only and the Unit 2 side was plunged into total darkness. Alarms that were sounding went silent and the MCR was for a second completely quiet. Without knowing what had happened operators doubted whether or not what they were seeing was indeed reality.

- Around the same time, two operators that had finished reactor protection system power restoration moved through the corridor in the Unit 2 turbine building basement to check conditions in the field when all of a sudden the lights went out and the sound of the D/G in operation disappeared as it stopped. In order to report the situation and seek safety, the operators thought to return to the MCR on the 2nd floor of the service building. On the way, water started to spray from the sides of the viewing window in the watertight door at the entrance to the D/G room in the turbine building basement. On the 1st floor of the turbine building, the door to the corridor that leads to the MCR on the 1st floor of the service building that is usually open was closed. When the two operators were finally to use all of their strength to open the door, a large amount of seawater flooded in. With the water at waist height, the two operators continued to head for the MCR. There was approximately 80cm of water in the 1st floor of the service building and objects close by were being swept away. They climbed the stairs and returned to the MCR completely soaked.
- MCR operators were made aware of the tsunami arrival when soaking wet operators returned to the MCR yelling, “Sea water is flooding in!”
- In the MCR, the Unit 1 side was illuminated by emergency lighting while the Unit 2 side was in total darkness. The shift supervisor gave instructions to check what instruments were working and if there was any equipment that was still operable. Operators gathered flashlights used for outside patrols and battery lights stored in the MCR to use as light sources when checking instruments. Operators searched for equipment that had working condition indicators lamps and that could be operated from the MCR.
- However, almost all indicator lamps had gone out and equipment could not be operated. The condition indicator lamp for the Unit 1 IC,

which was being used to control reactor pressure by opening and closing the return piping containment isolation valves (MO-3A), had gone out making it impossible to confirm if the valve was open or closed and the valve could not be operated from the MCR so operators did not know whether it was working or not. All of the condition indicator lamps for the HPCI on control panels had also gone out thereby making startup impossible. The condition indicator lamps on the control panels for the Unit 2 RCIC, which had been started up manually just prior, had also gone out making it impossible to determine if it was working or not. All the condition indicator lamps for the HPCI on the control panels had gone out and it was not possible to start it up.

- At 15:50, it was confirmed that reactor water level was unclear. In addition to AC power, all DC power was also lost thereby resulting in a total loss of power. The shift supervisor immediately relayed all confirmation results to the power generation team in the power station ERC.
- With operators returning soaking wet, the basement of the turbine building flooded by the tsunami, word that the 1st floor of the service building was flooded, constant aftershocks, and the issuance of a large tsunami warning, it was impossible to leave the 2nd floor MCR in order to check the conditions in the field.
- Several operators mentioned that they wanted to check conditions in the field for restoration purposes. The shift supervisor also felt the necessity to confirm conditions in the field, however the level of safety was not known and necessary safety equipment was not available making it impossible to head into the field at present time.
- However, with equipment condition indicator lamps out and the inability to confirm instrument indicators in the MCR, the shift supervisor gave instructions to begin preparations to head into the field in order to confirm the status of damage within the building for future restoration purposes, ascertain the routes by which water was flooding in, ascertain the degree of water damage to power facilities caused by the tsunami, and confirm what equipment was operable in order to ascertain plant status including the impact of the earthquake and tsunami.

- At 16:25 on March 11, the shift supervisor notified the power station Emergency Response Center (ERC) that the event described by Clause 15 of the Nuclear Emergency Act had occurred since emergency course then by cooling systems (CSC) could not be used and reactor water level was still unable to be confirmed.
- Ultimately, wireless phones were rendered unusable and the only way to communicate between the MCR and the ERC was by two hotlines. (The same with the Unit 3 and 4 and Unit 5 and 6 MCRs).

<Unit 3 and 4 Main Control Room >

- Operators that had been conducting evacuations at the service building on the sea side returned to the MCR shouting, “There’s a huge tsunami right off shore!”
- The tsunami caused D/G to stop as well as a total loss of AC power, but the condition indicator lamps for the Unit 3 RCIC and HPCI, which can be operated using DC power sources, were still on.
- As a result of the SBO, the Unit 3 side of the MCR was lit by emergency lighting only and the Unit 4 side was plunged into total darkness. LED lights that had been introduced in February for patrolling the field were used to check the parameters, such as reactor water level, of mainly Unit 3 since Unit 4 had been undergoing outage.
- Furthermore, in accordance with operating procedures during a SBO, load was severed from everything except absolutely necessary equipment, such as monitoring and operation control equipment, in order to preserve battery life needed for operating the RCIC and HPCI.
- At 16:03, the RCIC was started up using an operation switch in the MCR, reactor water level, RCIC discharge pressure, and revolution speed were confirmed, and efforts began to secure reactor water level.
- Operators were monitoring the tsunami from the 3rd floor of the service building. The tsunami had reached the height of the colonnade on the sea side. Thereafter, the tsunami receded and upon seeing the outlet and inlet surrounded by what looked like a sandy beach, operators were frightened that the next wave would be

even larger than the first and reach the MCR on the second floor of the service building.

- Operators headed to the field upon receiving word that workers in the ceiling train on the 5th floor of the Unit 3 reactor building were unable to get down from the crane. The 5th floor director building was lit only by emergency lighting and water are thought to have been caused by sloshing was confirmed on the floor; however there were no other abnormalities. The two workers were found by the wall near the ceiling crane and operators helped each of the workers down one by one using a flashlight.

<Unit 5 and 6 Main Control Room >

- It was confirmed that the two Unit 5 D/G and the two Unit 6 D/G had shut down as a result of the tsunami. The frequency of one other Unit 6 D/G was adjusted and kept in an operational state.
- The lights in the Unit 5 MCR fell, leaving only emergency lights in operation, but the emergency lights started to gradually dim and ultimately went out leaving the MCR in total darkness. Unit 6 lights stayed on as normal.

[Body surveys and dose measurements]

- At 15:50 on March 11, several members of the safety team began performing surveys of workers that had evacuated from control areas without undergoing body surveys in the parking lot in front of the seismic isolated building. Area Passive Dosimeters (APD) with alarms were recovered and personal IDs and doses were recorded.
- Meanwhile, since workers received information that workers had headed directly to the main gate and west gate, around 17:00 on March 11, several members of the safety team were dispatched to the main gate and west gate. Out of workers who were attempting to go home, surveys were performed on those workers that had evacuated from control areas without undergoing body surveys, their APDs were recovered and their personal IDs and doses were recorded. These surveys continued until around 24:00.
- In the seismic isolated building, approximately 50 APDs that had been stored as disaster prevention equipment were gathered and

started to be lent out to workers in the field from 16:53 on March 11. When an APD was lent out, the name of the person it was meant given to and where they were working was recorded, and doses were recorded when the APD was returned after work had been concluded.

- Approximately 5000 APDs that are used normally had been stored at the entrance to controlled areas in the service building; however most of these are rendered inoperable by the tsunami. APDs that had been lent out at the time of the earthquake and also those in the field that had not been damaged by the tsunami were recovered, and by the night of March 12, approximately 320 APDs had been secured. These were recharged and lent out as necessary.

[Measurements by monitoring cars]

- At the power station ERC, the safety team team leader ordered the deployment of monitoring cars since monitoring from monitoring posts used to measure radiation levels at the borders of the site could not be done. At 16:30 on March 11, the safety team left by monitoring car.

- The monitoring cars proceeded through congestion caused by people evacuating from the power station and arrived near the gymnasium. At 17:00 on March 11, radiation levels were measured to be 47nSv/h (normal levels).
- Thereafter, the monitoring cars moved through the site and took measurements at several points near monitoring posts and confirmed that radiation levels were normal. After 19:45 on March 11, it was decided to park the monitoring cars near the main gate and take fixed point measurements of neutron rays, wind direction, and wind speed in addition to gamma rays. Measurements were taken

and recorded approximately every 10 min. and the measurement results were conveyed to the power station ERC via radio.

[Evacuation and tsunami monitoring by the fire brigade]

- Following the earthquake, the fire brigade gathered on their own initiative in a room on the first floor of the seismic isolated building which had been determined in advance as a meeting place, changed into fire suits and was on standby.
- As the tsunami arrival continued, the fire brigade guided evacuees to the seismic isolated building at the five way intersection at the top of Shiomi Hill (step road leading to the sea side), and restricted people and vehicles from going to the sea side. There were people who tried to return to pick up personal items that they had left when they evacuated after the earthquake, but all these people were stopped since the tsunami could be seen pushing inland from their location.
- At 16:46 on March 11, there was word that a fire might have broken out next to the auxiliary building, so two members of the fire brigade headed into the field with four members of the safety team. When they arrived on scene, it was confirmed that the fire was actually just water spray. At this time, operators that had evacuated to the top of the auxiliary building and were unable to descend were discovered and the power station ERC and MCR were notified. Measurements taken by accompanying safety team members confirm that radiation levels in the field were normal. Five operators headed to the field and rescued the operators on the roof of the auxiliary building at 18:22.
- At 18:00 on March 11, the fire brigade was instructed by the site superintendent to monitor the tsunami. The fire brigade monitored the tsunami on 2 to 3 hour shifts near the training building on the high ground near the ocean. After night fell, the headlights of work vehicles were used to monitor the sea side. On the early morning of March 12, word was received that Unit 1 was to be vented so the fire brigade evacuated to the seismic isolated building.

[Verifying the soundness of rows within the site]

- At around 16:00 on March 11, after receiving information that the road near the main gate had been damaged, two employees accompanied by several contractors put on work clothes, snowsuits, and helmets, and started walking to the main gate in order to verify the soundness of roads within the site. A part of the road right outside the main gate had collapsed but vehicles could still pass.

The heavy fuel tank was carried to the north side of the Turbine Building by the Tsunami

- The employees went out of the main gate and went to confirm the road to the west gate. They returned along the same road.
- Next, when heading down the road in front of the old main building towards the sea side in order to check the roads heading to Units 1 to 4, a heavy fuel oil tank that had been swept away by the tsunami was found to be blocking the road, thereby prohibiting access. The employees left the road and went behind the building to get to the sea side to confirm the unloading wharf and the road on the sea side of Units 1 to 4.
- Assuming that it would take time to verify the soundness of roads by walking, the team returned to the seismic isolated building to secure a work vehicle and then headed in the work vehicle to the seaside taking roads that were passable. The roads on the seaside were littered with scattered debris allowing room for only one car to pass at a time.

Heavy fuel oil tank swept up by the tsunami and blocking the road (Diameter: 11.7m Height: 9.2m)

Site road cracked and impassable

- Next, the team headed to the Unit 5 and 6 side. After proceeding past protected areas of Unit 5 and 6 and heading to the mountain side, it was found that the road had caved in. When the team got out of the vehicle and proceeded on foot to check roads up ahead they found that the slope on the west side of the Unit 5 reactor building had caved in and collapsed due to a landslide thereby rendering the road impassable.
- The team returned by the same road and headed to Unit 5 and 6 on the mountainside in order to verify the soundness of access roads. A difference in grade had been created in the access road rendering it impassable. The situation required that roads be restored so as not to hinder future power station restoration work.
- At 19:24 on March 11, employees reported on the results of the road check to the power station ERC conveying that:
  The west gate is passable
  The road in front of the old main building is impassable
  The road on the sea side of the Unit 2 turbine building is impassable
  The unloading wharf is littered by debris and impassable
  The slope on the west side of the Unit 5 reactor building had caved in 35cm

[Implementation of work to restore roads on site]

- It was decided that the access roads to Unit 5 and 6 would be restored based on the results of the site road soundness verification.
- Contractors on-site to perform power station seismic tolerance enhancement construction were asked to supply heavy machinery. A backhoe (hydraulic shovel) and a dump truck for carrying gravel needed to correct the grade difference were secured.
- Three employees put on workloads, snow suits, and helmets, and headed into the field. They met up with contractors transporting heavy machinery and approximately ten workers engaged in restoration work.

Damage to the access road to Unit 5, 6
(After restoration, the asphalt on one side was stripped off and gravel and rocks underneath were used to restore the other side.)

In addition to the gravel loaded into the dump truck, gravel and rocks exposed from beneath cracked asphalt on the side of the road that was impassable was also used for restoration purposes. The backhoe was used to make the other side of the road flat again.

- At 22:15 on March 11, restoration work was completed and it became possible to access Unit 5 and 6. This fact was conveyed to the power station ERC.
- After work was finished, the backhoe was parked next to the gymnasium in preparation for the next job.
- Damage to the access road to Unit 5 and 6
- (After restoration, the asphalt on one side was stripped off and gravel and rocks underneath were used to restore the other side.)

[Securing transportation routes to protected areas]

- The protected area gate on the Unit 1 to 4 side that was normally used was washed away by the tsunami and roads on the sea side were littered with debris scattered by the tsunami. Vehicles could not pass.
- On the evening of March 11, the restoration team headed for the field in order to open other protected area gates. The gate closest to the seismic isolated building could not be opened due to driftwood and other materials washed in by the tsunami, so the gate in between Unit 2 and 3 was opened.
- At around 19:00 on March 11, tools were used to open the gate between Units 2 and 3 thereby securing a transportation route for vehicles to Unit 1 to 4.

[Work to restore temporary lighting in the main control room]

- As instructed by the power station ERC, three to four members from the restoration team and seven contractors began work to secure lighting in each MCR since lighting in each MCR had been lost.
- Contractors on-site set up small

The assistant shift supervisor working at his desk with temporary lighting generators that they owned and used for work in the transformer area on the mountain side of the Unit 1 and 2 and Unit 3 and 4 reactor building where transformers are located.

- A retractable extension cord was connected from the small generators to the Unit 1 and 2 and Unit 3 and 4 MCRs and then connected to temporary lighting. Although quite limited, temporary lighting was lit at 20:47 and 21:27 in the Unit 1 and 2 MCR and Unit 3 and 4 MCR, respectively.
- Thereafter the small generators were periodically refueled.

[Work to restore instruments in the main control room]

- The restoration team started gathering necessary schematics as well as batteries and cables from companies on site in order to restore instruments in the MCR. Teams of two to three people walked from the seismic isolated building to contractor offices to load batteries they had gathered into work vehicle borrowed from contractors, after which they proceeded through the gate between Unit 2 and 3 and transported them to the Unit 1 and 2 MCR.
- Gathered materials were carried into the MCR where schematics were confirmed and materials started to be connected to instrument panels in the Unit 1 and 2 MCR. Since Nuclear Emergency Act Clause 15 Incident: Core Cooling System Cooling Water Injection Failure had occurred and ascertaining the status of cooling water injection into the reactor was a priority, restoration work began by first connecting the batteries to reactor water level gauges that run on DC power sources.
- Even after the establishment of temporary lighting in the MCRs, the area behind control panels where work was being done was still pitch black, so flashlights were used to confirm wiring diagrams and cable numbers, and connect and process wire terminals.
- At 21:19 and 21:50 the reactor water levels were confirmed in Unit 1 and Unit 2, respectively.

- Thereafter batteries were continually procured by removing them from work vehicles on site and having them delivered by Self-Defense Force helicopter from the Hirono thermal power station.

Temporary batteries were connected to instruments to power them

Indicators were checked using flashlights

[Support from the Kashiwazaki-Kariwa Nuclear Power Station]

- The Kashiwazaki-Kariwa Nuclear Power Station (NPS) experienced an earthquake registering intensity 5 upper, so the site superintendent along with emergency disaster countermeasures personnel gathered in the seismic isolated building and proceed to verify the soundness of the facility. The conditions at both Fukushima Daiichi NPS and Fukushima Daini NPS were ascertained through teleconferences. The Kashiwazaki-Kariwa site superintendent instructed all departments to deliberate on what type of assistance they could provide to Fukushima Daiichi and Fukushima Daini. It was assumed that there would be a great need for assistance from the radiation control and fire brigades (fire engines), so these departments prepared for dispatch.
- Radiation control support personnel consisted of 15 members of the safety team and 2 drivers for a total of 17 people. One microbus type monitoring car and another microbus were prepared and loaded with food, and materials necessary from the standpoint of radiological protection, such as protective clothing. In conjunction with a request from Fukushima Daiichi for support the team departed at 19:30 on March 11.

- The monitoring car and microbus took separate routes as they headed for the power station to insure that at least one bus would arrive considering that the condition of roads leading to Fukushima Daiichi was unknown. Luckily, both routes were passable and the buses were able to safely meet up with each other at the TEPCO dorm near the power station.
- At 2:49 on March 12, the power station ERC was notified that support personnel arrived at the main gate of Fukushima Daiichi. Support personnel carried in the materials they had brought with them into the first floor of the seismic isolated building and consulted with the safety team leader in regards to activities ongoing at site. It was decided that the support personnel would help workers with the donning and removal of equipment at the entrance to the seismic isolated building, perform contamination surveys of workers that had returned from the field, and manage the opening and closing of the double doors at the entrance to the seismic isolated building. The monitoring car was used along with one other monitoring car at the power station to begin measuring radiation levels outside.
- It was confirmed that two out of the three fire engines at the Kashiwazaki-Kariwa NPS could be dispatched to Fukushima Daiichi. Contractors charged with fighting fires using fire engines were consulted and approval was obtained to dispatch fire engine operators to Fukushima Daiichi. In conjunction with a request for support from Fukushima Daiichi preparations were made and the fire engines departed for Fukushima Daiichi. The power station ERC was notified that one fire engine had departed at 21:44 on March 11, and the other had departed at 22:11.
- Thereafter, Kashiwazaki-Kariwa provided much support in the form of materials and personnel to Fukushima Daiichi and Fukushima Daini. It continued to provide support even as the situation worsened at Fukushima Daiichi and support personnel worked in unison with Fukushima Daiichi personnel.

[Disseminating information, such as evacuation announcements]

- The PR teams at the power station and headquarters disseminate information by updating the company's website every couple of hours with monitoring data and information on the status of the power station.

- At 20:50 on March 11, Fukushima Prefecture ordered an evacuation of residents living within a 2km radius of the power station and at 21:23 as the prime minister ordered an evacuation of residents living within 3km of the power station, the headquarters location team wrote a public announcement and asked private broadcast companies in Fukushima Prefecture to broadcast an evacuation notice over the radio. As conditions of the plan changed information continued to be disseminated in this way over radio and TV tickers.

[Return home/evacuation of contractors and female employees]

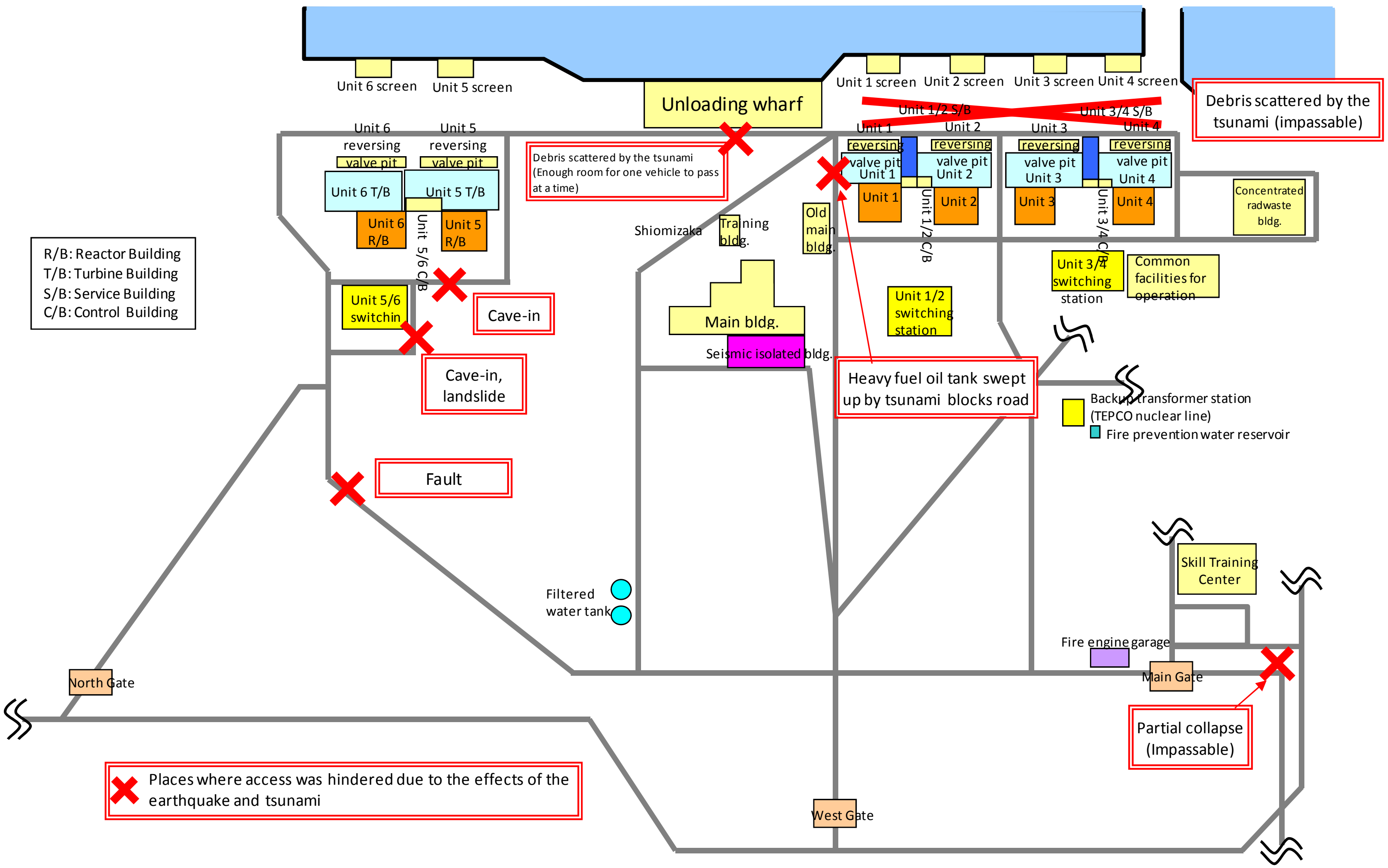
- Excluding necessary personnel, many contractors returned home from the power station following the earthquake and tsunami. It was also ordered at 17:08 on March 11 that TEPCO employees that were able to return home should do so.
- At around 5:15 on March 12, buses started carrying mainly contractors and female employees that had evacuated to the seismic isolated building to evacuation areas designated by the local government. In order to prevent the influx of radioactive materials into the seismic isolated building after evacuees were gathered at the entrance to the seismic isolated building the safety team opened both of the double doors and had all evacuees rush outside it once after which they immediately closed the doors. In order to minimize the ingestion of radioactive materials evacuees held their breath and covered their mouths with handkerchiefs until they could get onto the bus. Safety team members accompanied each of the two buses as they headed for the evacuation areas. After arrival at the evacuation area safety team members performed body surveys of evacuees as they exited the bus and confirmed that no one was contaminated before they entered the evacuation center.
- The bus made several roundtrips between the seismic isolated building an evacuation center to bring evacuees to the evacuation center. Thereafter, to more buses were added to provide transport to the evacuation center.

  Transportation to the evacuation center continued on March 13. One bus was used to make multiple trips to the evacuation center.

As monitoring means for ascertaining plant status were gradually being secured through the restoration of lights and instruments, workers in the field continued to handle the incident in total darkness, with limited communications tools, and amidst continuing aftershocks and tsunami alarms.

There were many workers who continued to work without knowing if their family was safe. There were employees who were not on duty that day who decided to exit the vehicle that their family was heading to the evacuation center in and go to the power station, as well as people who headed to the power station after finishing local fire brigade activities. It was under various conditions like these that personnel gradually started to appear at the power station. There were operators that encouraged each other by saying that they were going to control the incident and get out of here to see their families again, and in the field some operators even more precious watches and rings that they had received from their family as good luck charms and also with the foresight that these items might help with identification if their bodies had to be disposed of due to contamination.

Under these circumstances, workers engaged in measures to control the accident under the command of the site superintendent such as reactor cooling water injection, PCV venting and power restoration. (Refer to the separate documents “Response Status concerning Cooling Water Injection”, “Response Status concerning PCV Venting Operation” and “ Response Status concerning Restoration of Power” for details)



Layout of the Fukushima Daiichi Nuclear Power Station

End

Response Status Concerning Restoration of Power at Fukushima Daiichi Nuclear Power Station

<u>Details of activities following "March 11 15:42 Determining and notifying station black out"</u>

Unit 1 and 2 lost not only all AC power sources but also DC power sources thereby plunging the plant into an emergency state where it could not be operated or its status confirmed. Restoring power as quickly as possible was necessary for ensuring the safety of the plant, however at the time it was unknown as to what damage the tsunami had caused to the power facilities of each unit or what power facilities were operational, so it was impossible to predict when power could be restored. It was also impossible to immediately head into the field to verify the soundness of power facilities since the large tsunami warning continued and there was no way of knowing when another tsunami would arrive.

It was under these circumstances that headquarters and the power station engaged in activities to restore power.

[Securing power supply cars]

- Through the teleconferencing systems of the emergency response center it was learned that the tsunami had caused a loss of power at the Fukushima Daiichi Nuclear Power Station (hereinafter referred to as, "power station"), so that headquarters nuclear power division asked the headquarters distribution department to deploy power supply cars. At 16:10 on March 11, the headquarters distribution department instructed all offices to secure high voltage and low voltage power supply cars and confirm transportation routes to the power station after which at around 16:50 High/low voltage power supply cars sent from all branch offices to Fukushima Prefecture in turn.
- At around 16:30 on March 11, the emergency response center at headquarters asked other electric companies for assistance in providing power supply cars. At around 18:15, it was confirmed that three high-voltage power supply cars from Tohoku Electric were heading to the power station.

- At around 17:50 on March 11, the emergency response center at headquarters asked the Self-Defense Force (SDF) to deliberate transporting power supply cars by helicopter air transport since it was assumed that the power supply cars would not be able to reach the power station as planned due to road damage and congestion. The headquarters distribution department had some of the power supply cars head to SDF bases. At the power station, approximately 30 contractor and employee vehicles were brought to the sports field and arranged with headlights on to create a simple heliport. After receiving word that a helicopter loaded with the power supply car had taken off several tens of workers headed to the sports field in anticipation of the helicopter's arrival, but information about the helicopter kept changing and ultimately word was received that the helicopter had not even taken off.
- Transporting the power supply cars by SDF helicopter or US military helicopter was deliberated, however at 20:50 on March 11, the idea of transporting power supply cars by helicopter was abandoned due to the weight of the power supply cars. The headquarters distribution department instructed power supply cars that were heading for the SDF bases to head to the power station by land routes.

[On-site confirmation of power facility status]

<Off-site power>

- At the power station Emergency Response Center (ERC), the restoration team gathered power related information reported by operators and wrote it down on a white board. However, amidst the confusion that ensued immediately after the tsunami arrival only bits and pieces of information were gathered and it was impossible to ascertain an overview of the damage.
- At around 16:00 on March 11, veteran employees of the restoration team volunteered to go into the field and confirm the status of switchyard which is the connection point with off-site power systems. Since the switchyard is on the mountainside and it was unlikely that the workers would be struck by a tsunami while engaged in this work, four restoration team members headed to the switchyard by car with the approval of the restoration team leader.

- The team took mountainside roads and arrived at the Unit 1 and 2 switchyard. At the switchyard, equipment, such as circuit breakers, had been damaged by the earthquake and some equipment had fallen.


Switchyard circuit breaker damaged by the earthquake and some equipment had fallen.

- Next, the team headed to the backup transformer station for the 66kV TEPCO genshiryoku line. No damage to the backup transformer station equipment was visible.
- Thereafter the team returned to the seismic isolated building and reported on the conditions in the field.
- After helping to prepare a simple heliport at the sports field for the transportation of power supply cars, at 20:34 on March 11, workers headed to check on the Unit 3 and 4 switchyard. No damage to the Unit 3 and 4 switchyard was seen but signs of flooding from the tsunami were visible.

• From the conditions in the field it was determined that whereas restoration of the switchyards would be difficult it would be possible to restore the TEPCO genshiryoku line.

<Electrical power distribution system>

• Large tsunami alerts and aftershocks continued but confirmation of the status of electrical facilities in the sea side buildings was necessary in order to restore power.
• Several veterans from the restoration team asked the restoration team leader if they could be allowed to volunteer to inspect the turbine building and service building. The restoration team leader instructed them to consult with each related section about the dangers associated with aftershocks and tsunami, and concerns about radiation levels. The restoration team leader authorized them to confirm conditions in the field only after taking precautions to ensure safety, such as wearing Alarm Pocket Dosimeter (APD), having health physics team and plant operation team members

accompany them, and immediately evacuating to higher ground in the event of another earthquake. At around 18:00 on March 11, five people from the restoration team, etc. started to check conditions in the field starting at Unit 1.

Conditions in Unit 1 1st floor turbine building M/C

Traces of flooding from the tsunami could be seen in the form of a mud line on the M/C fence. (photographed days after the disaster)

- The team passed through the debris scattered by the tsunami on the sea side and entered the building through the Unit 1 turbine building truck bay.
  Sand and seaweed was adhered to the 6.9kV high voltage power panels (M/C) and 480V low voltage power panel (P/C) located on the 1st floor, and there were signs of approximately 1m of flooding. At around 18:30 on March 11, this information was conveyed to the power station ERC restoration team by wireless phone. It was reported within the power station ERC that power receiving facilities at the TEPCO genshiryoku line showed signs of being flooded and would be difficult to restore.
- Next, the team tried to take the Matsu corridor to the control building, but the earthquake and tsunami knocked over tool shelves and left seawater accumulated in various places making passage impossible. The team went outside and took a road on the mountain side to get to the aforementioned building.
- The team proceeded using flashlights, passed the heavy fuel oil tank that had been swept up by the tsunami and was now blocking the road to the road on the mountain side. The team walked carefully since manhole covers had been dislodged and there were many areas of the road that had caved in. The condition of the Unit 1 and 2 transformers were checked in the mountain side transformer area and the equipment did not look damaged, but there were signs of flooding by the tsunami.
- The team took the road between Units 2 and 3 to get to the sea

side and entered the Unit 1 and 2 service building. Walking through helmets and APDs that had been scattered about when racks fell, the team continued on and arrived at the electrical equipment room in the basement of the control building that houses P/C (1C) (1D) and DC power source equipment. Since water had accumulated to the water barrier of the electrical equipment room (height: 30~40cm), the team looked off in the distance and confirmed signs of P/C (1C) (1D) flooding.

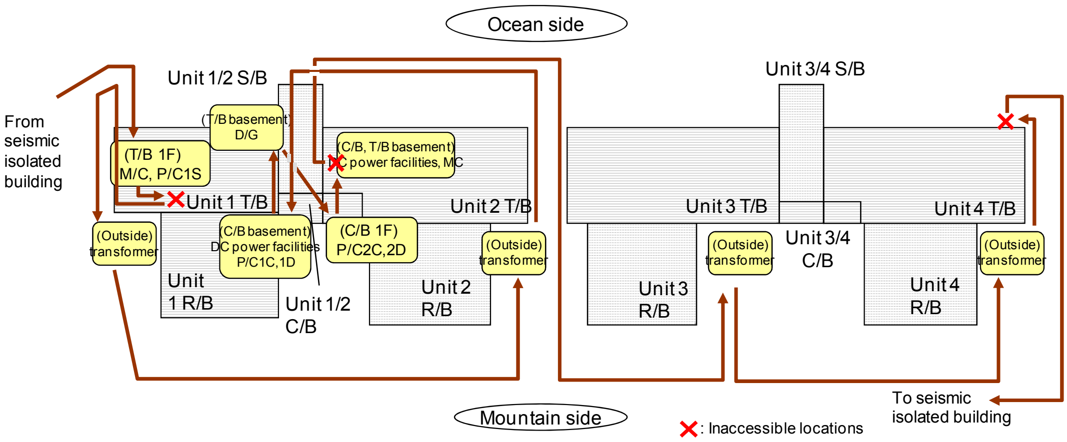
- The team headed to the emergency diesel generator (D/G) room on the same floor and confirmed that the D/G (1A) control panels showed signs of approximately 1m of flooding and that the D/G in the D/G (1B) room, which is at a lower elevation, was submerged in water.
- Next, the team proceeded to the 1st floor of the Unit 2 turbine building where the electrical equipment room that houses the Unit 2 P/C is located. The floor of the electrical equipment room was covered by approximately 5cm of water but no signs of flooding could be seen at the Unit 2 P/C.
- The team attempted to move to the basement to check the condition of the Unit 2 M/C and DC power sources, but gave up because the water level was at about 1.5m.
- After the condition of electrical facilities in the Unit 1 and 2 buildings had been checked the team headed to the Unit 1 and 2 MCR. Some of the condition indicator lights on the Unit 1 side were still on, but the Unit 2 side was completely dark.
- Next, five workers headed to inspect the Unit 3 and 4 side. The team passed by tractor trailers and debris that was blocking the road and arrived at the Unit 3, Unit 4 transformer area. There was no visible damage to the Unit 3 and Unit 4 transformers, but signs of flooding by the tsunami were confirmed.

Conditions at Unit 3/4 transformer area after debris and tractor trailers had been pushed aside (photographed days after the disaster)

- The team also tried to get to the Unit 4 turbine building truck bay by taking the road next to Unit 4, but debris, such as trucks, had been scattered about preventing access. Roads on the sea side were scattered with debris thereby preventing access to Unit 3.

Truck that had been stuffed into the back of the Unit 4 truck bay (photographed in the days after the disaster)

- Large tsunami alerts continued and high tide was forecasted for 20:09 so instructions were given to return from the field before then so the team turned back to the seismic isolated building.
- Measurements taken by accompanying health physics team members showed that radiation levels were normal.



Overview of Inspection

<Reporting the results of soundness verification>

- At 20:56 on March 11, the following information about the status of electrical power distribution system equipment was reported to the power station ERC along with the results of the inspection carried out by operators.
  - Unit 1: M/C, P/C inoperable
  - Unit 2: P/C may be operable. M/C is inoperable
  - Unit 3: M/C, P/C inoperable
- Since it was determined through checking the status in the field of

electrical power distribution systems and off-site power that restoring off-site power quickly would be difficult and that early restoration of the D/G and M/C etc. would also be difficult since they were flooded, workers aimed to restore power by using operable electrical power distribution system equipment and power supply cars.

- Meanwhile, the transmission department work to restore off-site power such as the restoration of the Shin Fukushima Substation had commenced on the 12th.

[Preparations to restore power to Units 1 and 2]

- Since the Unit 3 reactor was being injected with cooling water but the status of cooling water injection for the Units 1 and 2 reactors was unclear, the restoration of power for Units 1 and 2 was given priority. From the evening of March 11, the restoration team commenced preparations to restore power such as procuring cables and selecting equipment to be restored.
  - Out of the Unit 2 P/C that were deemed to be operable, the Unit 2 P/C (2C) power transformer (6.9kV/480V) was chosen to be restored due to the load connected and the ease of cable laying. At around 23:00 on March 11, two members of the restoration team and one contractor proceeded through the dark using flashlights to inspect the field and confirmed that the temporary cable penetration seal used for outage work of the Unit 2 turbine building was usable. It was decided to position high voltage power supply cars next to the Unit 2 turbine building in the vicinity of these penetration seals.
  - It was decided that the standby liquid control system (SLC),

The cable in the photograph is approximately 15m long and weighs approximately 90kg. A cable more than 10 times this length was used to restore power to Unit 1 and 2 (photographed in the days after the disaster) which is capable of injecting cooling water into the reactor, would be restored, so power supply routes, such as the location of the 480V small capacity low-voltage power panel (MCC) connected to each piece of equipment, was confirmed.

- Equipment schematics were used to calculate the distance over which temporary cables would have to be laid, and it was calculated that the length of the 6.9kV cable from the "high-voltage power supply car~P/C" (high-voltage side) was approximately 200 m, and the length of the 480V cable from the "P/C~MCC/each piece of equipment" (hereinafter referred to as, "low-voltage side") was approximately 80m.
- It was confirmed that there was a high-voltage side cable used for Unit 4 outage work stored in the offices of contractors near the power station (hereinafter referred to as, "off-site company offices"), so work to cut the appropriate length of cable began at the off-site company offices. It took workers several hours to cut off the appropriate length of cable by hand from the approximately 2 m high cable drum which they laid in a figure eight in order to prevent the cable from twisting and then loaded into a 4t unic truck at around 24:00.
- At around 22:00 on March 11, it was confirmed that the first of many support power supply cars en route had arrived from Tohoku Electric in the form of a high-voltage power supply car. At around 23:30, a SDF low-voltage power supply car arrived. Debris that had been scattered on the road between Unit 2 and 3 was cleared by hand, and after a path was made the power supply car was guided to the site. The Tohoku Electric high-voltage power supply car was positioned on the road between Unit 2 and 3 and put on standby until preparations to transmit power to the P/C, such as laying cables, could be finished. The SDF low-voltage power supply car was moved to the Unit 1 transformer area in order to provide power to lights and instruments in the MCR, but since a small generator was already in use for this

purpose, initially the low-voltage power supply car was not used and was placed at the Unit 1 transformer area.[1]

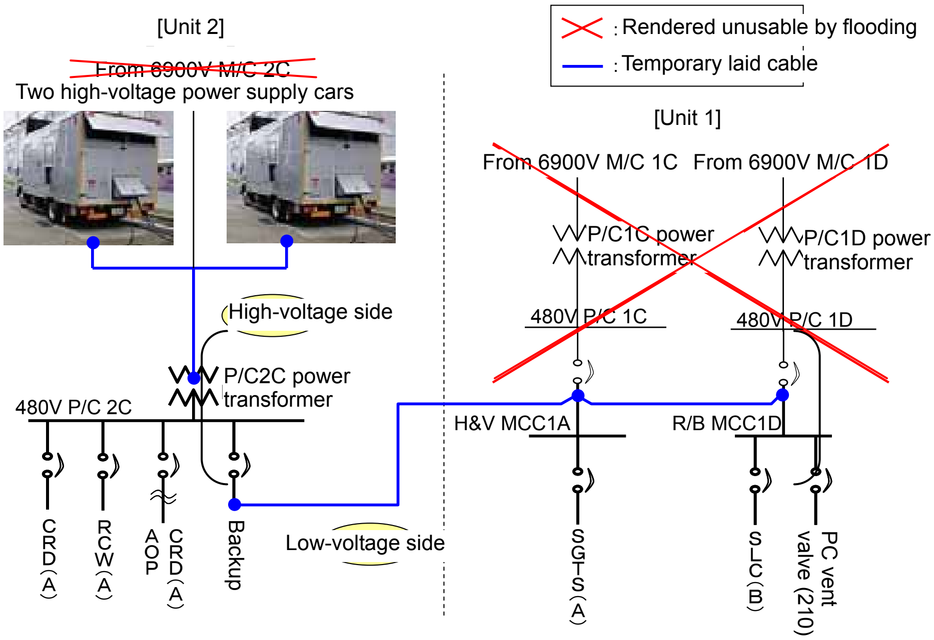
Low voltage. Needed to be towed since the generator was loaded on a trailer (photographed in the days after the disaster)

Tohoku Electric high voltage. As with high-voltage, temporary cables needed to be laid and terminals processed in order to send power to the P/C (photographed in the days after the disaster)

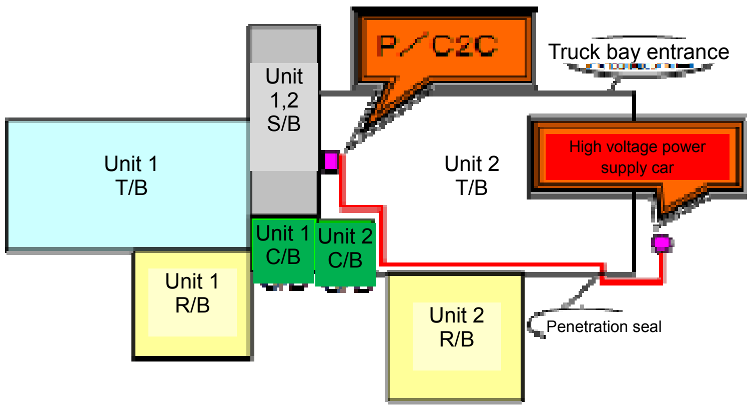
- Around 23:00 on March 11, three employees headed to open the truck bay of the Unit 2 turbine building which had been closed. The workers tried to open the shutter of the truck bay using tools but to no avail, so around 24:00, contractor heavy machinery arrived and was used to open the shutter.
- In order to verify the soundness of the Unit 2 P/C (2C) that showed no signs of flooding, the restoration team and contractors headed to the Unit 2 turbine building. After arrival at the P/C (2C), workers began removing cables connected to the P/C. Workers spent several hours cutting through the insulation tape wrapped several times around the wires that had melted together over the years and disconnected the cables. Thereafter, the insulation resistance was measured and it was confirmed that the unit was usable. At the same time, a different team measured the insulation resistance of the SLC side at the Unit 1 P/C and confirmed that it was usable.
- Approximately 20 employees including non-electrical engineers were mobilized to lay cables. How to carry the

[1] The SDF low voltage power supply car has both outlet and terminal type cable connections, so connection incompatibility is not the reason why the power supply car was not used.

cables and where workers should be positioned was explained in the seismic isolated building.



Unit 1, 2 power supply route



Units 1 and 2 cable laying route diagram

(High-voltage side cables carried in and laid to P/C2C. Thereafter one end of the cables were put through the penetration seals and connected to the power supply car located next to the building.)

[Unit 1 and 2 power restoration work]

<Unit 2 P/C and Unit 1 MCC power restoration>

- Right before cables were about to be laid after materials have been prepared, an aftershock occurred. The Tohoku Electric high-voltage power supply car and high-voltage side cables were moved to high ground out of the fear of a tsunami and workers evacuated to the seismic isolated building.

- At around 1:20 on March 12, four high-voltage power supply cars from Tohoku Electric and one TEPCO high-voltage power supply car arrived. By around 3:00 a total of eight TEPCO high-voltage power supply cars and seven low-voltage power supply cars had arrived. Since the TEPCO power supply cars had arrived before anything was connected, the restoration team decided to use the TEPCO power supply cars.
- At around 2:00 on March 12, cables started to be laid. The high-voltage side cable is more than 10cm in diameter and a length of approximately 200m weighs more than a ton. Normally it would take several days to lay such a cable using heavy machinery, but approximately 20 TEPCO employees and contractors carried it out at a hurried pace.
- An aftershock occurred while cables were being laid so workers evacuated to the second floor of the turbine building. The workers were forced to wait more than an hour before being able to resume work.
- Workers laying cables were wearing normal work clothes so between around 4:00 and 5:00 on March 12, all of these workers were ordered to evacuate to the seismic isolated building due to rising radiation levels
- Thereafter around 7:00 on March 12, restoration team workers and contractors put on equipment and resumed work. The workers continued to lay the high-voltage side cables and also process the terminal ends of cables that needed to be connected to the P/C. Terminal end processing is special work

Reconstruction of cable laying work

Workers were spaced approximately every 5m on the cable so that one person was carrying tens of kilograms of weight that consists of affixing the connecting ends of each wire in a 3 phase (3 wire) cable. So, one cable requires six (3 wires on both ends) terminal ends to be processed. This was done by multiple engineers over several hours.

- Also at around 7:00 on March 12, restoration team workers and contractors began work on the low-voltage side. It was confirmed that low-voltage side cables were stored in an on-site contractor warehouse so the cables were cut and carried out. Since the Unit 1 reactor building (R/B) could not be entered due to high radiation levels, cables were laid and connected from the P/C (2C) to the P/C (1C) and P/C (1D) in the basement of the Unit 1 control building and existing cables were used from that point forward to transmit power to the SLC load, etc.
- Working around power panels while standing in the dark in water brought with it the fear of electrocution. Cables related and connected being careful not to get cables wet. Furthermore, since there was water at the workers feet tools could not be placed on the floor so someone was required to shine the flashlight as well as hold tools.

Terminal connected to cables during terminal processing
Six places (3 wires x 2 both ends) needed to be processed.

This photograph is of the same type of cable connection used during power restoration. (Photographed in the days after the disaster)

Cable connections to power panel. The 3 wire cable terminals are affixed with bolts and then wrapped with insulation tape.

- In the early hours of March 12, TEPCO power supply cars were arriving and bus transport of evacuees to the evacuation center near the power station were beginning, so Tohoku Electric support workers also evacuated. Three high-voltage power supply cars were left at the power station and one was moved to the nearby evacuation center after which around noon it was returned to the Tohoku Electric office.

- At around 8:00 on March 12, two restoration team members and five TEPCO distribution team members headed into the field to position high voltage power supply cars. Since high radiation levels prohibited workers from being in the field for extended periods of time, the TEPCO high voltage power supply cars were positioned between Unit 2 and 3 after which the workers returned to the seismic isolated building. Thereafter one more TEPCO high voltage power supply car was positioned and preparations were made to transmit power with the two cars connected in parallel.
- Since touching the power supply cars or high voltage side cable connections will result in electrocution, scaffolding onsite was used to build a makeshift fence around the equipment.
- At around 10:15 on March 12, it was confirmed that a total of 72 power supply cars dispatched by TEPCO and Tohoku Electric had arrived in Fukushima. This meant that there were 12 high voltage supply cars at Fukushima Daiichi and 42 at Fukushima Daini, and 7 low voltage supply cars at Fukushima Daiichi with 11 at Fukushima Daini. In addition, 4 SDF low voltage power supply cars had also arrived.
- High voltage side cables were laid from the high voltage power supply cars to the Unit 2 P/C (2C) power transformer, and low voltage side cables were laid from the Unit 2 P/C (2C) spare circuit breaker to the Unit 1 P/C (1C) and P/C (1D).
- Connection of the high voltage side cables and low voltage side cables was completed around noon and at 14:10 on March 12, respectively. Thereafter, P/C circuit breaker turning-on preparation was completed thereby concluding power transmission preparations, so at around 15:00 the distribution department started up the power supply cars.
- The restoration team and contractors were on standby in front of the P/C (2C) when they heard the sound of the power transformers becoming excited and confirmed that power transmission had

commenced. First the receiving circuit breaker on the upstream side was manually turned on and the P/C (2C) started receiving power. Then, the circuit breaker on the downstream side of the P/C (2C) was manually tripped and power started to be transmitted to the Unit 1 side. The team moved to the Unit 1 side and used instruments to measure the voltage and phase sequence of the P/C thereby confirming that there were no problems with sending power to the Unit 1 side.

- Thereafter, the restoration team and distribution team finished adjustment of the power supply cars by around 15:30 on March 12. The team moved to a place with wireless phone reception and had just finished notifying the power station ERC that work had concluded when the Unit 1 R/B exploded.

<Restoration of power for Unit 1 and 2 instruments>

- Around 8:00 on March 12, four members of the restoration team headed to the field in order to restore power to Unit 1 and 2 instruments. They set up a small generator near the entrance inside the Unit 1 and 2 service building and connected six to seven cable reels up to the cable bolt room on the first floor of the Unit 1 and Unit 2 control building. Around 15:00 on March 12, the cable end of the cable reel were processed and attached to the cabinet panels of each of the instrument for Unit 1 and 2 after which power was transmitted.

[Unit 3 and 4 power restoration work]

- After the cables were prepared for Unit 1 and 2 an entire drum of high-voltage side cable was transported in a unic truck from the power station off-site company offices in order to restore power to Unit 3 and 4 and temporarily placed next to the road between Unit 2 and 3. The cable would be cut off on-site when restoring

Cable drum approximately 2m in height (photographed in the days following the disaster) power.

<u>Details of the activities engaged in following "March 12 15:36 Explosion occurred at Unit 1 Reactor Building"</u>

[Conditions at time of explosion]

- When two members of the restoration team were giving notification by wireless phone in a parked car near the gate between Unit 2 and 3 that work had concluded, they suddenly heard and felt the shock of an explosion. After confirming that neither party was injured, the two workers looked outside the vehicle to find the distribution team leader lying on the ground behind the car. They rushed to help him get up, discovering that he was not injured but that his ears were ringing severely as a result of the explosion.
- The three members then headed to a power supply car and met up with four members of the distribution team. In order to prevent a secondary disaster they shut down the power supply car and evacuated to the seismic isolated building. The windshield of the work vehicle that they were driving was shattered resembling a spider web, making it difficult to see, but they were just able to make it to the seismic isolated building.
- After they arrived at the seismic isolated building, they noticed that the clothes of one of the members of the distribution team had been punctured by debris from the explosion. Along with the distribution team leader whose ears were still ringing, the two went to receive a medical exam.
- Thereafter, restoration work could not be resumed until the conditions in the field were confirmed. In particular, since the cause of the explosion was unknown, it was impossible to resume work near the exploded Unit 1.
- The small generator that had been set up on the night of March 11, in order to provide temporary lighting to the Unit 1 and 2 MCR was damaged in the explosion and ceased to transmit power.

[Unit 3 power restoration]

<Verifying the soundness of power facilities>

- Without knowing the cause of the Unit 1 explosion, the restoration team was uneasy about heading into the field, but one veteran restoration team member and one health physics team member headed to Unit 3 and 4 to check which power facilities could still be used.

  - The two workers entered the Unit 4 turbine building through the truck bay. They moved past the truck that had been pushed into the back of the truck bay and proceeded through scattered debris to head towards the electrical equipment room on the first floor of the turbine building. Thereafter they confirmed that the Unit 4 P/C looked usable.
  - Thereafter the two workers tried to go to Unit 3, but the fire door in the corridor leading to the Unit 3 and 4 control building had been deformed and could not be passed through, so the two workers turned back to the seismic isolated building.

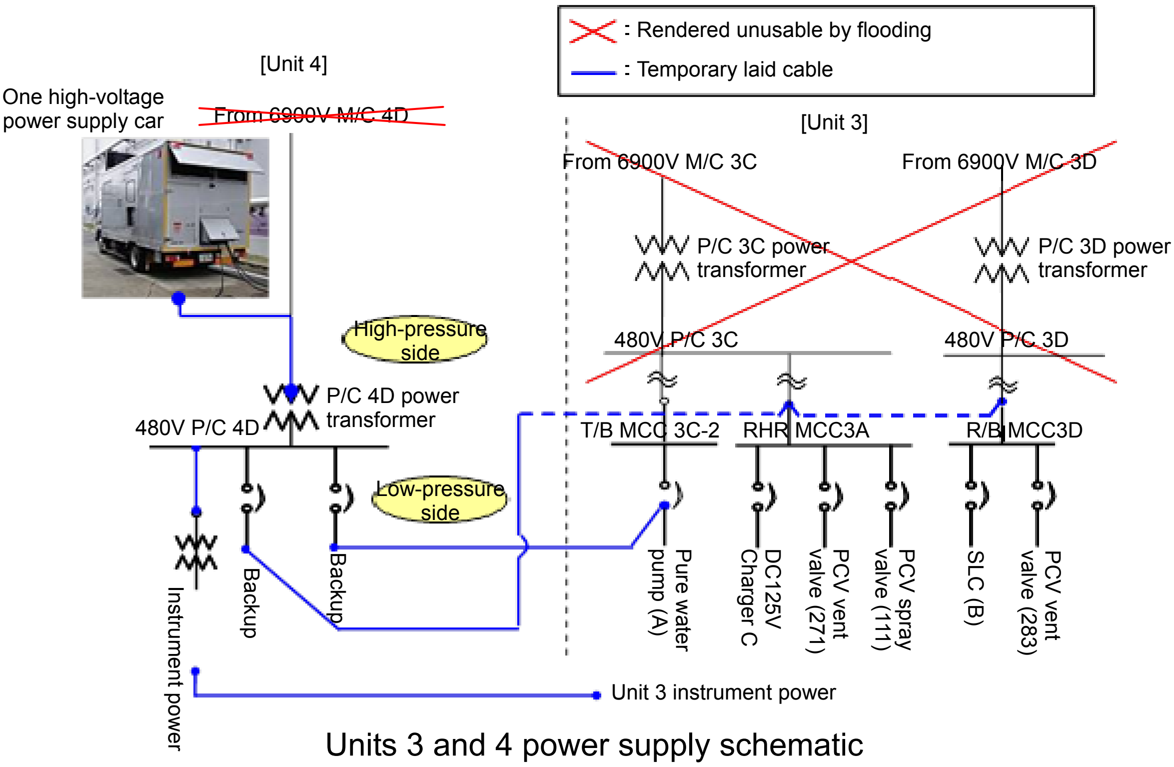
- At 20:05 on March 12, the power station ERC was notified that the Unit 4 P/C might be usable.

<Power restoration preparations>

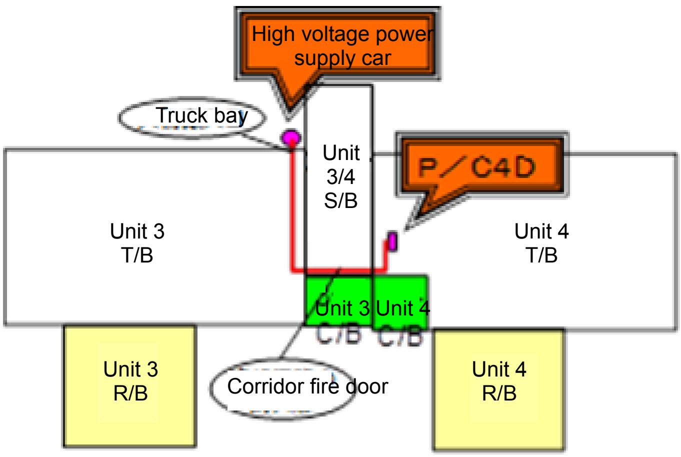
- It was decided that the recharging panels for the PCV venting valve, DC power source equipment, and SLC pump, which can inject cooling water into the reactor, would be restored at Unit 3.
- On the afternoon of March 12, a backhoe was used to clear road obstacles left by the tsunami in order to position the high-voltage power supply car.
- One restoration team member and two contractors headed into the field at 22:30 on March 12, in order to secure a cable laying route. They first headed to the on-site training facility to obtain gas tanks. They loaded the gas tanks into a vehicle and transported them to the Unit 3 turbine building where the truck bay shutter was closed and had to be cut open with torches. They continued on into the building and cut through the deformed fire door in the corridor to the Unit 3 and 4 control building. Since they were engaging in firework, they proceeded carefully by first cleaning up combustible materials that had been scattered in the area by the earthquake and tsunami and also having a fire extinguisher on hand, and that around 3:00 on

March 13 were able to secure a cable laying route.

- In the early morning of March 13, it was confirmed that the high-voltage side power cable that had been prepared in advance for Units 3 and 4 power restoration had been damaged by the Unit 1 R/B explosion and was unusable. At around 6:30 on March 13, two members of the restoration team headed to power station off-site company offices along with contractors in order to once again transport high-voltage side cable. After several hours, a length of high voltage side cable approximately 280 m long was cut off and the terminals of the cable were processed at the aforementioned offices.
- Also at around 6:30 on March 13, a separate team of restoration team members and contractors headed to the power station on-site contractor warehouse to cut off a length of low voltage side cable and process the terminals.
- Approximately 20 workers were secured in order to lay the cable and how to carry the cable and where people should stand was given in the seismic isolated building. Workers prepared by donning full face masks and ingesting iodine tablets and began work in the field at around 10:00 on March 13.



Units 3 and 4 power supply schematic



Units 3 and 4 cable laying route diagram

(The shutter to the truck bay and the fire door in the connecting corridor were cut open with torches and high voltage side cables were laid from the high voltage power supply car positioned in front to the P/C4D.)

<Power restoration work>

- Preparations on the low voltage side finished first and cables started to be laid. The building was in total darkness and work had to be done using flashlights which were scarce so no one was allowed to work alone.

- A low-voltage side cable was laid from the Unit 4 P/C(4D) to the airlock of the Unit 3 R/B, and the airlock were opened in order to lay cable to the MCC located inside R/B at which time the team saw white mist inside. Communications equipment was practically unusable so the team returned to the main control room (MCR) and used the hotline to notify the restoration team of the conditions. Any further work was suspended and at around noon on March 13, the cable was wound at the entrance and temporarily stored.
- Around this time the high-voltage side cable arrived on site so work continued to begin laying the high-voltage side cable. After a high-voltage side cable was laid from the high-voltage power supply cars to the Unit 4 P/C(4D) the high-voltage power supply car was started up at 14:20 on March 13 and power started to be received by the Unit 4 P/C(4D).
- Simultaneously three members of the restoration team started laying different low-voltage side line cables. cable reels were gathered and carried from the Unit 3 and 4 service building and terminals were processed at the brighter location. At 14:36 on March 13, a low-voltage side cable was finished being laid from the Unit 4 P/C (4D) to the Unit 3 turbine building MCC. The team met up with members of the restoration team that had completed laying the high-voltage side cable and split off into two groups to be on standby in the MCR and the Unit 3 turbine building in order to start up the pure water transport pump, but they received word to retreat due to the possibility of a Unit 3 explosion and evacuated to the seismic isolated building after meeting up in the MCR.
- At around 0:00 on March 14, four members of the restoration team headed into the field in order to restore power to Unit 3 instruments. The cable in front of the airlock of the R/B was appropriated to lay a low-voltage side cable from the Unit 4 P/C (4D) to the Unit 4 control building instrument cabinet panel. Then another low-voltage side cable was laid from the cabinet panel to the Unit 3 control building instrument cabinet panel. At 4:08 on March 14, partial function was

restored to the Unit 4 spent fuel pool water temperature gauge and Unit 3 containment atmospheric monitoring system (CAMS).

- At around 10:00 on March 14, two members of the restoration team started to restore the Unit 3 condensate transfer pump. At the Unit 3 turbine building MCC the team had just taken the power supply cable connected to the pure water transfer pump, which had already been restored, and connected it to the terminals of the condenser transfer pump when the Unit 3 R/B exploded.

[Unit 1 and 2 power restoration]

- In order to resume power transmission to the Unit 2 P/C(2C), which had stopped as a result of the Unit 1 explosion, at 8:30 on March 13, high voltage power supply cars were started up and an attempt was made to resume power transmission to the Unit 2 P/C(2C) but to no avail. When the cause of the failure was investigated it was found that the high voltage side cables had been damaged.
- The approximate 30m length of cable that had been damaged was to be cut out and new cable was spliced in so cable was cut and transported from the power station off-site company offices. Right before 15:00 on March 13, when workers were heading to restore power to Unit 2 the order was given to evacuate immediately so the workers returned to the seismic isolated building.
- At around 9:00 on March 14, three members of the restoration team and the health physics team resumed Unit 2 power restoration. The health physics team had received instructions prior to heading into the field that if something happened they should retreat to places where radiation levels are lower, so the team took radiation level measurements in the field very carefully. Just when the damaged portion of the high voltage cable had been cut out and new cable spliced in an explosion occurred at the Unit

Truck that had been placed in front of the Unit 4 truck bay (photographed days after the disaster)

3 R/B.

<Unit 1 and 2 instrument power restoration>

- After the Unit 1 explosion, four members of the restoration team and the distribution team positioned a low voltage power supply car at the entrance of the truck bay in order to restore power to Unit 2 instruments. At around 22:00 on March 12, the power supply car was connected to the Unit 1 and 2 cabinet panels and power transmission was resumed.

<Unit 1 and 2 Main Control Room temporary light restoration>

- The small generator that had been damaged by the Unit 1 explosion was replaced with another one setup at the entrance to the Unit 1 and 2 service building. Power transmission was resumed on the night of March 12, and operators periodically refueled the generator.

Details of activities engaged in following "March 14 11:01 Explosion Occurred at Unit 3 Reactor Building"

[Conditions at the time of the explosion]

- Power restoration work was underway in the Unit 2 and Unit 3 turbine buildings when the Unit 3 explosion occurred.
- In the Unit 2 turbine building a dreadful roar was heard followed by a thick cloud of dust. Fleeing outside, workers noticed that the windows of their vehicle had been shattered, the roof caved in and the vehicle itself had been blown by the shock of the blast to another location. Three members of the restoration team ran back to the seismic isolated building.
- The health physcis team that was in the truck bay of the Unit 2 turbine building thought immediately that it was an explosion and not an earthquake. Upon going outside and taking measurements of the dust high radiation levels of 50mSv/h were measured so they stood by in the building until the smoke cleared. Thereafter they ran back to the seismic isolated building. They avoided scattered debris on the road while taking radiation level measurements along the way. There were places along the way that measured 100mSv/h.
- In the Unit 3 turbine building two members of the restoration team

were subject to strong vertical vibrations and a deafening roar. Unit 4 P/C (4D) power receiving stopped as a result of the Unit 3 explosion. Outside debris scattered by the explosion was falling to the ground. The two workers waited inside until the debris had fallen and then ran through the debris to their vehicle and returned to the seismic isolation building. However, the car could not pass due to scattered debris on the road so they left the vehicle and ran back to the seismic isolated building.

[Power restoration]

- Work to restore off-site power has continued since it was started by the transmission department and distribution department on March 12. Work has been balanced with the other work of spraying of water into the spent fuel pool and power started to be received by the Unit 2 P/C(2C) at 15:46 on March 20, and by the Unit 4 P/C(4D) at 10:35 on March 22. The lights in the MCRs of all units were restored using off-site power by March 29.

MCR light restoration (Unit 4)

End

Timeline of major events at Fukushima Daiichi Nuclear Power Station Unit 1 from the occurrence of the earthquake until March 12 (Sat.)

March 11, 2011 (Fri.)

14:46 Tohoku-Chihou-Taiheiyo-Oki Earthquake occurred. Reactor was automatically shut down (scram). Level 3 state of emergency automatically issued.

14:47 Main turbine automatically shut down, emergency diesel generators automatically activated.

14:52 Isolation condenser system (IC) automatically activated.

15:02 Reactor confirmed to be subcritical.

15:03 IC return piping containment isolation valves (MO-3A, 3B) temporarily set to “fully closed” to ensure reactor coolant cool-down rate of 55ºC/h. Reactor pressure control with IC began afterward.

15:06 Emergency Response Center for general disasters established at headquarters (for understanding earthquake damage status and restoring power)

15:27 First tsunami wave arrived.

15:35 Second tsunami wave arrived.

15:37 Station black out (SBO)

15:42 Situation (SBO) deemed to fall under Article 10, Section 1 of the Act on Special Measures Concerning Nuclear Emergency Preparedness (hereinafter referred to as “Nuclear Emergency Act”), and government agencies were notified.

15:42 Level 1 state of emergency for nuclear disasters issued. Emergency Response Center (ERC) for nuclear disasters established (joined with Emergency Response Center for general disasters).

Around 16:00 On-site road soundness checks began.

Around 16:00 Power source facility (off-site power) soundness checks began.

16:10 Headquarters Distribution Department ordered all branch offices to secure high/low voltage power supply cars and confirm transport routes.

16:36 Situation (ECCS cooling water injection function loss) was deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to reactor water level being unable to be confirmed and injection status being

unclear, and government agencies were notified at 16:45.

16:36 Level 2 state of emergency issued.

16:45 Situation (ECCS cooling water injection function loss) deemed to no longer fall under Article 15, Section 1 of the Nuclear Emergency Act due to the confirmation of reactor water levels, and government agencies were notified at 16:55.

Around 16:50 High/low voltage power supply cars sent from all branch offices to Fukushima Prefecture in turn.

16:55 Diesel-driven fire pump (DDFP) field checks began.

17:07 Situation (ECCS cooling water injection function loss) was deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to reactor water level being unable to be confirmed yet again, and government agencies were notified at 17:12.

17:12 Site Superintendent ordered to begin deliberation on reactor injection methods using Fire Protection System (FP) lines installed as an Accident Management (AM) measure, as well as fire engines.

17:30 DDFP automatically activated due to fault recovery operations, but shut down since alternate reactor injection line assembly was not complete (kept in shutdown status afterwards to prevent startup).

Around 18:00 Power source facility (Electrical Power Distribution System) soundness checks began.

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

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

18:35 Alternate reactor injection line assembly began.

Around 19:00 Gate between Units 2 and 3 opened, securing vehicle travel routes to Units 1 through 4.

19:24 On-site road soundness check results reported to station ERC.

20:47 Temporary lighting turned on in the Main Control Room (MCR).

20:50 Due to completion of alternate reactor injection line, maintaining the shutdown status of DDFP was halted. DDFP was automatically activated afterwards via fault recovery operation (state where injection after reactor depressurization would be possible).

20:50 Fukushima Prefecture ordered evacuation of residents within a 2km radius of Fukushima Daiichi Nuclear Power Station (NPS).

20:56 Power source facility (off-site power, Electrical Power Distribution

System) soundness check results reported to station ERC.

21:19 Reactor water level confirmed to be top of the active fuel (TAF) +200mm.

21:23 Prime Minister ordered evacuation of residents within a 3km radius of Fukushima Daiichi NPS, and retreat to indoor areas for residents within a 3km to 10km radius of NPS.

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

21:51 Reactor Building (R/B) entry forbidden due to R/B radiation level increase.

Around 22:00 Arrival of one high voltage power supply car from the first group of Tohoku Electric confirmed.

22:10 It was notified to government agencies that reactor water level was around TAF +450mm.

23:00 Survey results showing Turbine Building radiation level increase (Turbine Building 1st floor in front of the airlock on the north side: 1.2mSv/h; Turbine Building 1st floor in front of the airlock on the south side: 0.5mSv/h) notified to government agencies at 23:40.

March 12, 2011 (Sat.)

00:06 Site Superintendent ordered to advance preparations for Primary Containment Vessel (PCV) venting (hereinafter referred to as “venting”) due to possibility of Dry Well (D/W) pressure exceeding 600kPa abs.

00:30 Evacuation as per order from the central government for residents confirmed to be completed (evacuation for residents within a 3km radius of Futaba and Okuma Towns confirmed to be completed, re-checked at 01:45)

00:49 Situation (abnormal PCV pressure increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to possibility of D/W pressure exceeding 600kPa abs, and government agencies were notified at 00:55.

Around 01:20 Arrival of one TEPCO high voltage power supply car confirmed.

Around 01:30 Request for approval of venting at Units 1 and 2 submitted to Prime Minister, Minister of Economy, Trade and Industry, and NISA, and were granted.

01:48 DDFP shutdown confirmed.

02:03 Deliberations on connecting fire engine to FP line intake began.

02:47 Government agencies were notified of D/W pressure reaching 840kPa abs at 02:30.

03:06 Press release on implementation of venting.

Around 04:00 Reactor fresh water injection from FP lines via fire engine began. Injection of 1,300L of fresh water completed.

04:01 Results of simulated venting exposure assessment notified to government agencies.

04:55 Site radiation level increase (near main gate: 0.069μSv/h (04:00) → 0.59μSv/h (04:23)) confirmed, and government agencies were notified.

05:14 "External leakage of radioactive materials" deemed to have occurred considering site radiation level increase and signs of D/W pressure drop, and government agencies were notified.

05:44 Prime Minister ordered evacuation of residents within a 10km radius of Fukushima Daiichi NPS.

05:46 Reactor fresh water injection from FP lines via fire engine restarted.

05:52 Injection of 1,000L of fresh water into reactor from FP lines via fire engine completed.

06:30 Injection of 1,000L of fresh water into reactor from FP lines via fire engine completed.

06:33 Deliberation of evacuation from Okuma Town toward Miyakoji confirmed.

06:50 Minister of Economy, Trade and Industry issued legally mandated order for venting (manual venting).

07:11 Prime Minister arrived at Fukushima Daiichi NPS.

07:55 Injection of 1,000L of fresh water into reactor from FP lines via fire engine completed.

08:03 Site Superintendent ordered venting operation target time of 09:00.

08:04 Prime Minister departed from Fukushima Daiichi NPS.

08:15 Injection of 1,000L of fresh water into reactor from FP lines via fire engine completed.

08:27 Information received that some areas of Okuma Town have yet to be evacuated.

08:30 Injection of 1,000L of fresh water into reactor from FP lines via fire engine completed.

08:37 It was notified to Fukushima Prefecture that preparations for venting operation with target time of 09:00 were underway. Agreement reached that venting would take place after confirming evacuation status.

09:02 Evacuation of Okuma Town (section of Kuma region) confirmed to be completed.

09:04 Operators headed into the field to perform venting operation.

09:05 Press release on implementation of venting.

09:15 Injection of 1,000L of fresh water into reactor from FP lines via fire engine completed.

09:15 PCV vent valve (MO valve) opened manually.

09:32 Field operation of suppression Chamber (S/C) vent valve (AO valve) bypass valve attempted, but halted due to high radiation levels.

09:40 Injection of 15,000L of fresh water into reactor from FP lines via fire engine completed.

09:53 Results of simulated venting exposure assessment notified once again to government agencies.

Around 10:15 The 72 power supply cars dispatched by TEPCO and Tohoku Electric confirmed to have arrived in Fukushima (high voltage power supply cars: 12 to Fukushima Daiichi and 42 to Fukushima Daini; low voltage power supply cars: 7 to Fukushima Daiichi and 11 to Fukushima Daini).

10:17 S/C vent valve (AO valve) bypass valve opened from MCR (expectation of pressure to remain within the instrument air system).

10:40 Likelihood of radioactive material release from venting operation considered high, due to radiation level increase confirmed at main gate and near monitoring post No.8.

11:15 Possibility that venting was not fully effective confirmed due to drop in radiation levels.

11:39 It was notified to government agencies that exposure dose for one of the TEPCO employees who entered the R/B to perform venting operation exceeded 100mSv (106.30mSv).

14:30 When installing temporary air compressors to open the S/C vent valve (AO valve) isolation valve around 14:00, it was confirmed that D/W pressure was dropping. This was deemed to be caused by radioactive material release due to venting, and government agencies were notified at 15:18.

14:53 Injection of a total of approx. 80,000L of **fresh water into reactor from FP lines via fire engine completed**.

14:54 Site Superintendent ordered implementation of reactor seawater injection.

15:18 Standby Liquid Control System (SLC) restoration work was underway. Plans were in place to activate the SLC pump for reactor injection as soon as preparations were completed. Plans were also in place to perform reactor seawater injection using the FP as soon as preparations were completed. These plans were notified to government agencies.

Around 15:30 Routes assembled to supply power to Unit 1 MCC from high voltage power supply cars via the Unit 2 P/C. Power transmission to areas near the SLC pump began and high voltage power supply car adjustments were completed.

15:36 Explosion occurred at R/B.

16:27 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (1,015μSv/h) measured near monitoring post No. 4, and government agencies were notified.

Around 17:20 Personnel headed out to survey fire engine and building conditions.

18:05 Information that the Minister of Economy, Trade and Industry had issued a legally mandated order (perform injection) was shared between the headquarters and the power station.

18:25 Prime Minister ordered evacuation of residents within a 20km radius of Fukushima Daiichi NPS.

18:36 Results of fire engine and building condition survey showed that the field was in disarray, with **damage to hoses prepared for seawater injection making them unusable**.

19:04 Reactor seawater injection using FP line via fire engine began.

20:45 Seawater mixed with boron injected into the reactor.

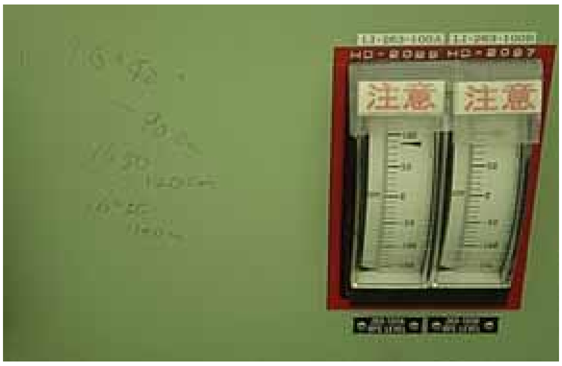
End

Response status concerning Fukushima Daiichi Nuclear Power Station Unit 1 cooling water injection

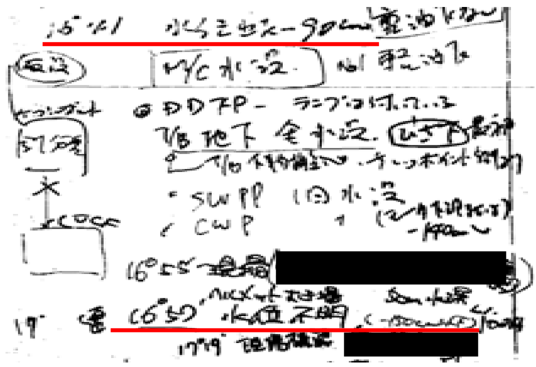
○Details of activity after "March 11 16:36 Determining and notifying Emergency Core Cooling System injection function loss"

[Reactor water level check]

- Operators used flashlights to check whether any instruments were operational in the main control room (MCR), which was lit only by emergency lighting. They discovered that reactor water level gauge readings, which were not visible before, could now be confirmed. The readings (equivalent to top of the active fuel (TAF) +250cm) were reported to the station Emergency Response Center (ERC) at 16:44 on March 11. Operators in the MCR continued monitoring reactor water levels by writing them onto whiteboards and control panels.



Reactor water level readings temporarily confirmed
(read values written next to gauge, monitoring continued)



Part of whiteboard
(values read off gauges written here and shared)

- Since reactor water levels could be confirmed, it was decided in the station ERC that the situation (**Emergency Core Cooling System (**ECCS) injection function loss) no longer applied to Article 15, Section 1 of the Nuclear Emergency Act, and this was notified to government agencies at 16:55 on March 11.
- Reactor water levels were continually monitored in the MCR, but could no longer be confirmed at 17:07 on March 11. Therefore, the station ERC deemed the situation (ECCS injection function loss) to fall under Article 15, Section 1 of the Nuclear Emergency Act, and this was notified to government agencies at 17:12.

[Reactor injection measure status check, deliberation, and operation]

<Preparations toward field checks>

- While operators in the MCR checked instruments and confirmed facilities that were usable as per Shift Supervisor orders, several operators began monitoring for tsunami from the rooftop of the service building (S/B). The situation in the seaside area (O.P. +4m area) after the tsunami arrival was beyond anything anyone could have imagined, as the tsunami had destroyed facilities and washed away heavy fuel oil tanks. Tsunami waves of various heights arrived numerous times, with some of them high enough to cover the seaside area. Thankfully, none of them reached the buildings.

- Condition indicator lamps had gone out, and instrument readings could not be checked in the MCR, meaning that station status was unknown. Therefore, preparations toward field checks were being advanced in the MCR.
- The Shift Supervisor deemed it unwise to send younger operators into the field. This was because field status remained unknown, with the only information being that tsunami flooding had reached the S/B 1F and “racks are in disarray; it is total darkness.” Since building entry routes needed to be checked and facility operability needed to be decided, operators who would head into the field were chosen based on how well they knew the field. Main members included the Shift Supervisor and Deputy Shift Supervisor.
- Awareness was shared between operators by stating their opinions on what should be checked where (including indoor status and power panel flooding status). Since operators would be heading into a field in total darkness where conditions remained unknown, this sharing of awareness was thoroughly repeated. It was not a task that ended in twenty or thirty minutes.
- Since aftershocks continued to occur and a large tsunami alert was still in effect, it was decided that pairs of personnel, the minimum allocable number, would head into the field, while leaving personnel in the MCR to perform rescue if needed. Furthermore, in addition to deciding that field check time would be limited and operators would only go to the destinations clearly stated beforehand, preparations were also made in case rescue would be needed. It was decided that helmets, flashlights, APDs and other equipment on hand at that time would be taken with the operators, and equipment that were short on supply would be retrieved from S/B 1F field waiting rooms where tsunami had arrived.
- While preparations for field check were underway in the MCR, it was discovered that “shutdown” was lit for the DDFP condition indicator lamp. It was reported to the plant operation team that the DDFP was in shutdown, at 16:35 on March 11.
- Operators who had headed out into the field post-earthquake came back to the MCR soaking wet and reports came in that the Turbine Building (T/B) basement floors were submerged and the S/B 1F was flooded, which also served as a factor that made it difficult to begin field checks, in addition to continued aftershocks and a large tsunami alert in effect. Since a preparation for field checks, including response in case of emergency, was made, the Shift Supervisor decided to begin field checks at the Reactor Building (R/B) and T/B to aid future restoration efforts.

<Diesel-driven fire pump (DDFP) response status part 1>

- While other operators were monitoring the tsunami situation on the roof of the S/B, operators headed to the fire protection system (FP) pump room at the T/B basement floor where the DDFP was located, at 16:55 on March 11. When heading into the field, various obstacles prevented them from going farther as T/B 1F hallways were littered with tool racks, which had fallen due to the earthquake and tsunami impact, and numerous pools of seawater. Although operators managed to traverse these obstacles and reach the R/B airlock, they were forced to turn back upon receiving reports of a coming tsunami from operators who had been monitoring for tsunami on the roof of the S/B, via a wireless phone.

<High Pressure Coolant Injection System (HPCI) response status>

- All HPCI condition indicator lamps in the MCR had gone off, and the HPCI could not be started up because DC power needed for operation control had been lost.
- The restoration team began post-earthquake/tsunami field checks on power facility status around 18:00 on March 11. There was water up to the edges of the water barrier (height: 30cm to 40cm) of the electrical equipment room at the Control Building (C/B) basement floor where the DC power facility was located, meaning that inspection of the said facility had to be halted.

○Details of activity after "March 11 17:12 Site superintendent ordered to begin deliberation on reactor injection methods using alternate injection measures installed as an Accident Management measure or fire engines (installed as lesson learned from the Niigata Chuetsu-Oki Earthquake)"

- Due to the foreseeable need for severely harsh severe accident response in the future, the site superintendent ordered deliberation on the use of alternate injection measures installed as an Accident Management (AM) measure (FP, make-up water condensate system (MUWC), primary containment vessel (PCV) cooling system) and of fire engines, at 17:12 on March 11.

<DDFP response status part 2>

- Operators who had headed into the field to perform DDFP field check but were forced to return received word from operators performing tsunami monitoring that, although tsunami had reached the coast, the waves were not very high. Therefore, those operators headed back into the field for field checks at 17:19 on March 11. Although the T/B basement floor was flooded, operators were able to enter the FP pump room after putting on long boots used for outdoor patrols.
- It was confirmed at 17:30 on March 11 that the "failure" status light on the FP control panel in the FP pump room was lit. When the fault recovery button on the FP control panel was

pushed, the DDFP automatically started up. It was decided that the DDFP would be kept in shutdown until the alternate injection line was ready. The plant operation team was notified that the DDFP had activated.

- For the next three hours, operators took turns holding the operation switch in the “shutdown” position in the MCR to ensure the DDFP did not automatically start up again.

<Isolation Condenser System (IC) response status part 1>

- Parameters (e.g., reactor pressure, reactor water level) and IC status could not be confirmed in the MCR, as the status display lights for various equipment (e.g. monitoring instruments, IC) had gone off due to power loss. The Shift Supervisor commissioned the plant operation team to confirm whether steam was being generated from the IC vent pipe, since this could not be directly confirmed from the MCR.
- Operators decided to check the R/B 4F IC shell-side water level gauge, in addition to reactor pressure gauges and conditions within the R/B. They did so because the IC condition indicator lamp had gone off, making it impossible to determine containment isolation valve status or whether it was functioning. They also considered securing a shell-side water feeding line, depending on the IC shell-side water level, if it was confirmed.
- The plant operation team checked the R/B IC vent pipe from the seismic isolated building parking lot at 16:44 on March 11, confirming that steam was coming out from the left side vent pipe.[1]
- Operators headed toward the R/B at 17:19 on March 11. They wore long boots with regular work clothes, carrying flashlights and GM counters (measuring devices for contamination detection). The T/B 1F hallways were blocked by tool racks that had fallen due to earthquake/tsunami impact, and seawater had pooled in several areas. This made it very difficult to press onward.
- Operators managed to go forward by avoiding fallen tool racks and arrived in front of the R/B airlock. There were pools of seawater in front of the airlock. Since operators had their hands full carrying flashlights and GM counters, they opened the outside airlock handle with their elbows. When they set foot inside, the indicators on the GM counters that they were holding went off the charts. Although operators changed the range several times, it recorded higher values than normal. Since GM counters were not the equipment that measures air dose, radiation levels inside the R/B were unclear. This unusual situation forced operators to halt field checks. They retreated at 17:50 on March 11 to report conditions.
- Meanwhile, operators in the MCR were checking operation procedures to deliberate what could be done. Their only sources of light were emergency lighting and flashlights. Operators discovered that certain DC power sources had been restored, and the IC return

1 Subsystem A vent valves are located on the left side of R/B IC vent valves.

piping containment isolation valve (MO-3A) and supply piping containment isolation valve (MO-2A) status display lights had come on. It was found that the "closed" status display lights were on.

・ Several operators gathered around the control panel where status display lights had come on to deliberate response. Since the IC supply piping containment isolation valve (MO-2A), which was normally open, had closed, operators derived at the possibility that an IC isolation signal[2] had been sent out.

・ Although the "closed" status light was on, there was concern that using the battery after it was flooded once would cause grounding and render it unusable. However, operators expected that the PCV internal isolation valves (MO-1A, 4A) were open, and performed an opening operation with the operation switch for IC return piping containment isolation valve (MO-3A) and supply piping containment isolation valve (MO-2A) at 18:18 on March 11. The condition indicator lamp changed from "closed" to "open" status. Operators confirmed that steam was generated after the opening operation was performed, with the sounds of steam generation and steam seen from the R/B.

IC external view (photo taken on October 18, 2011)

The red portion is the IC body. It is believed the gray thermal insulation material had been stripped away due to the explosion.

・ The MCR notified the station ERC that the opening operation for two valves had been performed and steam generation was confirmed. Upon receiving this report, the station ERC acknowledged that the IC was operating. It would be necessary to provide water to the shell side if IC operation continued, but the Engineering Team reported that feeding via the FP line was possible.

[2] Loss of IC control power (DC power) led to the activation of the "IC pipe rupture" detection circuit, sending out an isolation signal.

- The amount of generated steam seen from the R/B was small, and it stopped shortly after. However, operators could not go into the field in total darkness and check the R/B IC vent pipes in person because at the time, the MCR could not find out the earthquake and tsunami damage status, and the large tsunami alert was in effect.
- The PCV internal isolation valves (MO-1A, 4A) closing due to isolation signal transmission was considered as a possible reason for steam generation stoppage. There was also concern over the possibility of shell-side water (IC coolant) running out.
- Upon considering the possibilities that the IC was not functioning and the fact that the feed lines needed for shell-side water supply were not prepared, operators closed the return piping containment isolation valve (MO-3A) at 18:25 on March 11. It was also decided that lining up of an alternate injection line via DDFP would be given top priority, since the alternate reactor injection lining up was not yet completed. The fact that the return piping containment isolation valve (MO-3A) closing operation was performed had not been reported to the station ERC.
- Operators expected that the HPCI condition indicator lamp would also come back on, as the DC power equipment for the HPCI was installed in the same area as those for the IC. They planned to activate the HPCI as soon as its condition indicator lamp came on, but the lamp ultimately did not come back on.

<Alternate reactor injection line deliberation and operation>

- AM operating procedures were submitted to the Shift Supervisor chair in the MCR in order to confirm alternate reactor injection measures, and the valves necessary for alternate injection line and their locations were confirmed. Lining up of an alternate reactor injection line from the FP line using the DDFP via the core spray system (CS) to the reactor was began at 18:35 on March 11. Line up could normally be done quickly via operation from the MCR, but the lack of power meant that operation could not be performed from the MCR, and thus it was decided that the operation would be performed manually in the field. Younger operators could not be sent into the field, due to reports that unusually high radiation levels had been measured. A total of five operators (four veteran operators and one member of the plant operation team) headed toward the R/B. They wore full face masks and APDs, and had to confirm field entry routes while pressing onward in the field in total darkness with only flashlights to guide them. Two FP Motor Operated (MO) valves on the R/B basement floor and three MO valves (including the CS) on R/B 2F were manually opened, and alternate reactor injection line up was completed around 20:30. There were no changes to the measurement results on the APDs they wore.

・ The handle for the manual operation of the CS intake valve was fairly large (diameter approx. 60cm) and its valve stem strokes were long. After operation, the full face masks worn by operators were filled with sweat.

<Confirming reactor pressure>

・ Since readings on the MCR monitoring instruments could not be confirmed due to power loss, operators went inside the R/B, which was in total darkness. They confirmed that reactor pressure was 6.9MPa on the R/B 2F reactor pressure gauge at 20:07 on March 11.

<DDFP response status part 3>

・ Since alternate reactor injection line up had finished, operators moved the MCR DDFP operation switch from the "shutdown" position at 20:40 on March 11. However, it failed to start up.

・ Because there were no methods for communication with the field, personnel were placed between the field and MCR to convey operation status. The MCR operation switch was moved from the "shutdown" position, while operators in the field kept pressing the fault recovery button. It was finally confirmed in the field that the DDFP had activated, at 20:50 on March 11. This enabled reactor injection to be performed after reactor depressurization (when DDFP discharge pressure becomes higher than reactor pressure).

<Securing water source for reactor injection>

Transformer FP pipe leakage

(The supports for other pipes on the sides of the FP pipe became slanted due to ground slip, bringing them into contact with FP pipe.)

・ The fire brigade and the plant operation team began work to stop leakage. This was due to confirmation that water was shooting out of fire hydrants and the transformer fire prevention piping was leaking, creating concern over the possibility that the filtered water tank (water source for FP) could run dry. The valves on the side of the main office building were closed to stop leakage from transformer fire prevention piping, but this proved insufficient. Therefore, work to close the filtered water tank outlet valve began. Since wireless phones could not receive signals because there was some distance between the seismic isolated building and filtered water tank, personnel were placed between the two areas to relay information. Several members of the fire brigade had to work in turn because the outlet valve handle was heavy and its strokes were long.

・ It was reported to the station ERC at 19:18 on March 11 that the fire brigade and the plant operation team closed the filtered water tank outlet valves for other lines but maintained the availability of the FP line necessary for reactor injection.

Filtered water tank

Tank outlet valve near filtered water tank
(All outlet valves other than the FP line needed for reactor injection were closed.)

<Confirming fire engine location>

・ Upon receiving orders from the site superintendent, at 17:12 on March 11, to begin deliberation on alternate water injection that included the use of fire engines, the Emergency Planning & Industrial Safety Department confirmed fire engine status with the contractors commissioned to use them to perform firefighting activities. Of the three fire engines deployed at the station, the one on standby in the garage was usable. The one located near the protection headquarters of Units 1 through 4 was damaged by tsunami. The one on the Units 5/6 side could not be used for several reasons, such as access to the Units 5/6 side being cut off due to road damage and tsunami debris and reports that it had been washed away by the tsunami.

・ The one usable fire engine was placed on standby next to the seismic isolated building and prepared for use.

<IC response status part 2>

・ Alternate reactor injection line up was completed, and operators were checking whether other response operations could be performed from the MCR when they discovered that the “closed” condition indicator lamp of the IC return piping containment isolation valve (MO－3A) was fading out.

IC vent pipe (nicknamed “pig’s nose”)

・ Operators confirmed on the IC technical materials that the IC could be operated for approx. 10 hours without makeup water for the shell side. Considering the operation status up to present, they believed that there was still water on the shell side. The DDFP had activated, meaning that water could be supplied to the IC shell side via valve operation, if this became necessary.

- The return piping containment isolation valve (MO－3A) condition indicator lamp was unstable and fading out, and it was not known when it could be operated again. Under such circumstances, operators, placing their expectations on the IC to operate, once again attempted opening operation of the once closed return piping containment isolation valve (MO－3A) at 21:30 on March 11. The valve successfully opened, with steam generation confirmed by the sound of steam generation and steam seen from the R/B. The plant operation team was notified by the MCR that valve opening operation had been performed. The plant operation team exited the seismic isolated building to confirm steam generation. Around this time, the station ERC believed that the DDFP, which was activated at 20:50 to maintain IC function, was being used to supply the IC shell side with water.
- Subsequently, two operators headed to the R/B to confirm IC shell side water level and reactor water level. When one of the two entered the R/B, leaving the other in front of the R/B airlock, the APD value rose to 0.8mSv in a very short amount of time, forcing them to halt field checks. They returned to the MCR to report this at 21:51 on March 11.

<Preparing for cooling water injection via fire engine>

- The Emergency Planning & Industrial Safety Department and fire brigade brought a simplified station model into the station ERC. They wrote information to be shared directly onto the model (e.g., site road traversability, water leakage). This allowed understanding of station status and performance of firefighting activities.

Simplified station model (photo taken at later date)

(Information is written here, such as tsunami monitoring performed on the day of disaster, and the injection line from the unloading wharf on March 14.)

- Relevant parties (e.g., restoration team, fire brigade) gathered for desktop deliberation and preparation for injection via fire engine, using diagrams. The intake installed near the building wall was on the T/B seaside, which was selected as the area where the fire engine would be connected. However, there was tsunami debris scattered in the area, necessitating the use of heavy machinery to remove debris so the fire engine could be parked there.
- The restoration team used heavy machinery to open Unit 2 T/B truck bay shutters and remove debris in the area around 00:00 on March 12. They did so as part of power restoration work. This allowed vehicles to access the seaside area.

<DDFP response status part 4>

- Operators started checking DDFP operation status at the FP pump room of T/B basement floor from around 01:25 on March 12. The DDFP had shut down, and although a fuel feed line had been configured, fuel was not being provided. It was confirmed that fuel had run out at 01:48. When DDFP startup battery voltage was confirmed on FP control panels, the voltage was rather low. The station ERC was notified of the situation at 02:03.

- The station ERC began deliberation on connecting the fire engine to the FP line intake, as well as field work.

○Details of activity after "March 12 02:03 Deliberations on connecting fire engine to FP line intake began"

[DDFP restoration]

<Fuel supply>

- DDFP fuel supply work began at 02:10 on March 12. Four operators collected containers (approx. 0.5L capacity each, a few dozen containers gathered) for carrying light oil from buildings. They did so while carefully walking on roads scattered with debris, lit only by flashlights.
- While monitoring for tsunamis from the S/B 3F, an operator worked under flashlight to remove stopper plugs from pipes for supplying D/G light oil, opened pipe valves, and filled containers with light oil.
- Operators placed the containers full of light oil into baskets placed in changing rooms used for entering controlled areas. They carried these baskets to the T/B 1F truck bay while avoiding debris along the way. Some were transported by handcart, while others were carried by hand. These were then carried by hand from the truck bay to the T/B basement floor FP pump room to fill the fuel tank there. Fuel supply was completed at 02:56 on March 12. DDFP startup operation was performed, but the DDFP did not activate.

<Battery replacement>

- Operators commissioned the restoration team to replace DDFP startup batteries at 02:10 on March 12.
- 2V batteries (weighing approx. 10kg each) arrived at the station from Hirono thermal power station at 06:34 on March 12. The restoration team loaded twelve of these into cars, transported them to the T/B truck bay, and then carried them to the T/B basement floor FP pump room with one in each hand. While carrying out replacement work, aftershocks forced them to evacuate. Contamination was detected during inspections at the seismic isolated building entrance, and these operators were isolated in a separate room.
- Three other members of the restoration team headed into the field to restart work. Work was finished at 12:53 on March 12. Operators attempted startup operation at 12:59, but this failed. It was reported to the station ERC at 13:21 that the cell motor had grounded and was

thus rendered unusable.

[Injection via fire engine]


Unit 1 FP line intake

- Preparations were underway to use the one fire engine on standby near the seismic isolated building to perform injection.
- The plant operation team and fire brigade headed to the T/B seaside area on a fire engine in search of outdoor FP line intakes at 02:10 on March 12. They joined with several operators who were performing DDFP oil supply and searched together, but could not find the intake due to scattered tsunami debris and the opened truck bay protective doors.
- Employees and contractor workers donned garments for protection against the cold and helmets, and then set out for the field. They began clearing debris near the Unit 1 T/B truck bay using backhoes. They also searched for the FP line intake, but were unsuccessful. They returned to the seismic isolated building at 03:30 on March 12.
- Employees knowledgeable about the field and members of the fire brigade headed to the field once again around 03:30 on March 12. They discovered the intake, located behind the truck bay protective doors. They began injection of the fresh water (1,300L) loaded on the fire engine around 04:00. There was a fire engine near the Units 1 through 4 side protection office that was damaged by tsunami. Operators attempted to use the water on it for injection. However, due to a field radiation level increase at 04:22, injection work was temporarily halted and personnel returned to the seismic isolated building.
- Contamination inspection was performed at the seismic isolated building entrance by the health physics team. Measurement devices readings showed high figures, meaning that there was physical contamination. The contaminated personnel were washed by dumping water over their heads. When they removed their clothes for re-measurement, contamination levels did not drop sufficiently. Due to contamination on their faces, there was concern for internal exposure (ingestion). Under orders from the health physics team, the contaminated TEPCO employees and fire brigade members were isolated in a separate room.
- Preparations toward additional fire engine deployment and water transportation by Self-Defense Force (SDF) were under way in the station ERC.
- MCR reactor pressure gauge power was restored at 02:45 on March 12, and it was discovered that pressure was 0.8MPa [gage].

○Details of activity after “March 12 05:46 Reactor fresh water injection from FP lines via

fire engine restarted”

<Fresh water injection commencement / continuation>

- Due to a field radiation level increase and isolation for contamination, the fire brigade leader requested continued cooperation from fire brigade contractors, and the said contractors agreed to drive and operate fire engines. The fire brigade leader and three members of the fire brigade put on full face masks and headed into the field at 05:46 on March 12. There, they restarted cooling water injection via fire engine.
- It was believed that fire engine discharge pressure would not be sufficient when injecting from the Unit 1 side FP tank. Therefore, the fire engine was loaded with water from the FP tank and moved closer to the T/B. Reactor injection was performed via the FP line intake from that position. Moving the fire engine took some time, as careful navigation was required when moving under crumbling buildings that could topple at any second.
- Members of the fire brigade later returned to the seismic isolated building and received contamination inspection, which revealed signs of contamination. Due to this, they were isolated in a separate room.
- Another fire brigade headed into the field on a fire engine to continue cooling water injection. The large amount of debris and other obstacles due to earthquake/tsunami impact meant that it would take time to move the fire engine. Therefore, a sequential injection line was assembled between the Unit 1 side FP tank and FP line intake by using hoses on the fire engine. Then, injection was performed.
- A fire engine installed with a water tank arrived at the station from Kashiwazaki-Kariwa Nuclear Power Station (NPS) around 10:30 on March 12. This supplied fresh water to the Unit 1 seaside FP tank from the Unit 2 mountain side FP tank.
- Two SDF fire engines arrived at Fukushima Daiichi NPS in the morning of March 12. One of these fire engines was used to assemble a line for providing water from the Unit 3 FP tank to the Unit 1 FP tank. However, personnel were forced to return to the seismic isolated building before fresh water could be transported due to high field radiation levels.

Buried FP tank (taken at time of installation)

FP tank manhole

<Seawater injection preparation commencement>

- Because early reactor injection was necessary, injection was continued by using an FP tank near the intake as a water source. This FP tank was supplied with water from other FP tanks. However, due to the limited amount of fresh water that could be secured for FP tanks and the effects on reactor injection if this supply were to run dry, the site superintendent ordered seawater injection preparations to commence, around noon of March 12, with the acknowledgement and approval of the Headquarters ERC director (President). The fire brigade began preparations toward seawater injection alongside FP tank fresh water supply, as per site superintendent orders.

Unit 3 backwash valve pit

(Unit 3 backwash valve pit was used as water tank, since it was relatively unaffected by tsunami debris and seawater was accumulated there.)

- Based on the condition of on-site roads and the distance to Unit 1, it was decided that seawater would not be directly taken from the ocean. Instead, the Unit 3 backwash valve pit was selected as a water tank, since seawater from the tsunami had accumulated there.
- Approximately 80,000L (cumulative) of fresh water had been injected as of 14:53 on March 12.
- The site superintendent ordered reactor seawater injection to be performed at 14:54 on March 12. As the amount of fresh water in the Unit 1 side FP tank had began to run low, work to transition to seawater injection was advanced while also hurrying transport of fresh water from other FP tanks.
- It was decided that the seawater injection line would have three fire engines arranged in tandem from the Unit 3 backwash valve pit. Placing fire engines and hoses were underway, but the explosion at Unit 1 occurred before it could be completed.

[Physical contamination measurement]

- The number of personnel for which physical contamination had been confirmed was reported to be 17 people as of 06:17 on March 12. However, this number continued to grow, and ultimately exceeded 30 people. The health physics team decided to transport contaminated people in buses to areas outside the station where radiation levels were lower, to ensure the levels of contamination could be accurately determined. They got a bus from the general affairs team for this purpose. Since all of the contaminated people could not fit onto the bus, they were split into two groups. One was loaded onto the bus, which headed off-site around 13:00 on March 12. They were accompanied by three members of the health physics team.

- It was believed that radiation levels would lower immediately upon exiting the station, but this did not prove to be the case, as radiation levels refused to decrease. Despite travelling by bus for nearly one hour to Kawauchi Village, figures were still not low enough to perform contamination measurement.
- The bus was stopped and measurement of the contaminated people was performed, but contamination levels ultimately remained unknown. The bus returned to the station, parking some distance away from the seismic isolated building. It was when the people on the bus had gotten off and started walking towards the seismic isolated building that the explosion at the Unit 1 R/B occurred.

○Details of activity after "March 12 15:36 Explosion occurred at Unit 1 Reactor Building"

[Conditions at time of explosion occurrence]

Situation of MCR after explosion

(Ceiling light covers fell off due to jolts, leaving only emergency lighting for light)

- Without warning, the MCR was rocked from side to side, accompanied by large noises. The entire room was enveloped in white dust. The sudden nature of this incident meant very little could have been done.
- At this time, the fire brigade was working with contractor workers to perform reactor injection via fire engine near the Unit 1 backwash valve pit. When they stepped out of their vehicles to fuel the fire engine, they were struck by a sudden shockwave, which forced them to crouch on the spot. Looking up, the sky was filled with debris that came crashing down around them. Contractor workers were led to the Condensate Storage Tank (CST) near the Unit 1 T/B. They took shelter from the debris alongside the tank's walls. When they took a look around several moments later, they discovered a contractor worker near the fire engine, who was unable to move. They called out to this worker, but the worker was unable to stand unassisted. Therefore, two other workers lent a shoulder each to help the worker evacuate. The fire brigade and contractor workers headed to the gate between Units 2 and 3, while shouting "There's been an explosion!" into their wireless communication devices. They placed the injured worker in a nearby vehicle and drove back to the seismic isolated building.

Car damaged by blast winds

(This car was used on the evening of March 11 to transport batteries, and had been parked near the Unit 1 main exhaust stack)

- Another fire brigade was riding with the SDF personnel in an SDF fire engine, and was performing seawater injection line configuration at that time. When driving between the Unit 2 and Unit 3 T/Bs, the ground looked like it twisted. At the same instant, a massive sound of explosion struck them, and blast winds shattered the windows of the fire engine. Debris came flying at them, which struck their arms and resulted in injury. The fire brigade and SDF drove back to the seismic isolated building in that fire engine.
- The people who returned from contamination measurement had just gotten off the bus and were starting to walk back to the seismic isolated building when the explosion occurred.

They were knocked down by blast winds, which also shattered the windows of the main office building and other nearby buildings. Forced to turn back, they quickly took shelter inside the bus. Thankfully, the bus was parked next to a building, which meant it had escaped the direct impact of the explosion.

- The inside doors of the seismic isolated building entrance had been knocked off its rails by the blast winds, meaning that they could not be opened or closed. Acting quickly, crowbars were used to pry the doors back onto their rails and restart airlock access control. Outside the building, white materials believed to be thermal insulation fell from the skies, as did sparks. The smell of something burning even reached the inside of the seismic isolated building. The ceiling of the access hallway between the seismic isolated building and main office building had become warped due to the shock of blast winds. Its airlock was stuck open and could not be shut. Poles were used to push the ceiling back up and somehow close the airlock, but the seismic isolated building was no longer completely airtight. This was the cause of later spreading of contamination within the seismic isolated building.

[Post-explosion response status]

- Massive lateral shaking and the sound of explosion were experienced inside the seismic isolated building at 15:36 on March 12. It was reported that D/W pressure could no longer be monitored from the Units 1/2 MCR. Thankfully, communication with the MCR was still possible.
- At 15:40 on March 12, the seismic isolated building TV monitor showed footage of the Unit 1 R/B exploding, with thick clouds of smoke streaming out and its metal framework exposed.

Unit 1 R/B after explosion

- It was reported to the station ERC at 15:49 on March 12 that several people had been injured due to the explosion. The station ERC began listing the injured and field work that had been performed, at 15:54, while the field evacuation order was still in effect.
- It was reported that reactor water levels could be confirmed from the Units 1/2 MCR at 15:57 on March 12. The station ERC believed the RPV was still sound, and unaffected by the explosion. Due to the effects of the explosion, the small generator being used to power temporary lighting, which had just been restored the day before, was destroyed. It was reported that the MCR was in total darkness, from the MCR.
- It was around this time that employees and workers who had been performing field work at the time of explosion occurrence began returning to the seismic isolated building. This allowed field conditions to be pieced together and understood. An employee who had been

assembling a line for reactor seawater injection via fire engine was injured by flying debris that came in from the windows of the fire engine, which were shattered by blast winds. He was sitting in the passenger seat of the fire engine at that time. It was reported that preparations to power the standby liquid control system (SLC) would be needed once again. SLC had previously been receiving power from power supply cars. Confirmation of worker safety (e.g., listing injured personnel, field work that had been performed) took place while the cause of explosion still remained unknown. Due to the need for swift restarting of reactor injection, it was decided that fire engines would be checked to see if they were usable, at 16:15 on March 12.

Main office, where windows were broken by blast winds

Former main office, where windows were broken by blast winds (Unit 1 can be seen to the right)

- It was confirmed at 16:17 on March 12 that radiation levels measured near monitoring post No.4 were 569μSv/h as of 15:31. This situation was deemed to fall under Article 15 of the Nuclear Emergency Act and government agencies were notified (notification was corrected when it was discovered that at 16:53 on March 12 that radiation levels had been 1,015μSv/h as of 15:29).
- Confirmation of worker safety revealed at 16:58 on March 12 that 5 people had been injured by the explosion (3 employees; 2 contractor workers who had been performing injection via fire engine). The injured first received body surveys from the health physics team, then received medical attention from the medical team in the medical room. They were later transported to a hospital.
- Because the cause and impact of the explosion remained unknown in the MCR, it was decided that all operators ranking below the Deputy Senior Operator would evacuate to the seismic isolated building. The Shift Supervisor, Deputy Shift Supervisor, and Senior Operator stayed behind in the MCR to collect data and continue field response under guidance from the station ERC.[3] During evacuation, the health physics team led the way while measuring radiation levels. When they returned to the seismic isolated building, they reported that outdoor radiation levels at the time were approximately 10mSv/h. The steel

[3] Monitoring at Units 1/2 and Units 3/4 MCRs from the evening of March 13 onward continued in shifts of the minimum number of operators needed.

framework was all that remained of the upper part of the Unit 1 R/B when they looked in that direction when evacuating.

[Response after physical contamination measurement]

- The bus that had previously carried contaminated persons was used to evacuate the health physics team and contaminated persons to Fukushima Daini. They contacted the Fukushima Daiichi health physics team with their wireless phones when they reached the main gate of Fukushima Daini. After discussing future response for the contaminated persons, they received orders to return to Fukushima Daiichi. The bus left Fukushima Daini and arrived at Fukushima Daiichi around 16:30. Contaminated personnel returned to their respective teams and groups to continue accident response.
- Upon deliberation with headquarters, the guideline value for contamination was changed from $4Bq/cm^2$ to $40Bq/cm^2$ in the early hours of March 13.

○Details of activity after "March 12 Around 17:20 Personnel headed out to survey fire engine and building conditions"

- The Unit 1 R/B roof had been blown off by the explosion, exposing the 5th floor SFP. It was decided at 17:20 on March 12 that SFP status would be confirmed the next day from a helicopter, when it was light out again.
- Contractor workers were injured in the explosion at Unit 1, and the possibility of future explosions could not be ruled out. Despite this, it was decided upon further deliberation that they would continue assisting efforts. The fire brigade began field checks of fire engine status around 17:20 on March 12. While performing field checks to restart reactor injection, it was reported by the head office ERC at 18:05 that the Minister of Economy, Trade, and Industry had ordered injection during their TV conference (order document received later).
- Even though the required pressure levels to perform PCV venting had not been reached, the site superintendent ordered Units 2/3 venting line up preparations to begin at 17:30 on March 12.
- Results of field checks began to be reported at 18:36 on March 12. Hoses prepared for seawater injection were damaged and unusable.
- Because highly radioactive debris was scattered near Unit 1, debris (e.g., Unit 1 R/B steel plates) was cleared under the guidance of the health physics team. Hoses to be used for injection line were

Injection via fire engine (deployment took place on later date) collected from outdoor fire hydrants, and laying work was advanced again.

- An injection line was assembled with three fire engines in arranged in tandem and using the Unit 3 backwash valve pit as a water source. Seawater injection began at 19:04 on March 12. This was reported to NISA around 19:06.
- Fellow Takekuro TEPCO's government liaison notified the headquarters ERC at 19:25 on March 12 that "the Prime Minister has not approved seawater injection at the official residence." Upon deliberation between headquarters and the station, it was decided that seawater injection would be temporarily halted.[4]
- During the first explanation, which began around 18:00, Prime Minister Kan expressed concern over the effects accompanying seawater injection and asked about the status of field preparations in some detail. This led fellow Takekuro to conclude that action could not be taken without the understanding of Prime Minister Kan. The Prime Minister demanded a thorough explanation that would reassure him that criticality recurrence would not be caused by seawater injection, and the relevant parties decided to prepare for a second explanation.[5]
- In light of the situation within the official residence stated above, temporary halting of cooling water injection was recommended for fear that advancing field work without the approval of the Prime Minister, who is the General Manager of the Nuclear Disaster Response Headquarters, could become a huge obstacle for an even more necessary coordination with government agencies in the future, and the belief that simply explaining the lack of criticality recurrence risk would keep the shutdown time short.
- The headquarters ERC believed that, because deliberation on seawater injection was being made with the Prime Minister, who is the General Manager of the Nuclear Disaster Response HQ, with advice from the Nuclear Safety Commission (NSC), performing seawater injection without the understanding of the Prime Minister would be difficult. Explanation from the liaison to the official residence at that time led to the belief that shutdown time would be short.
- However, due to the site superintendent's judgment that reactor injection was of the utmost importance in preventing accident progression, seawater injection continued in actuality.

End

4 There are several accounts verifying that fellow Takekuro directly contacted the station regarding this matter, but no other evidence to prove this has been confirmed.

5 The fact that this action could not take place without the understanding of Prime Minister Kan can also be estimated from the fact that a second order for seawater injection came from Prime Minister Kan at 19:55, despite the initial order for seawater injection two hours earlier at 17:55 from Minister of Economy, Trade and Industry Kaieda (for a detailed timeline, refer to the "facts regarding seawater injection for TEPCO Fukushima Daiichi NPS Unit 1 on March 12 (re-revised edition)" released by the government-TEPCO unified response headquarters on June 10, 2011) .

Response status concerning Fukushima Daiichi Nuclear Power Station Unit 1 PCV venting operation

○Details of activity after "March 11 16:36 Determining and notifying Emergency Core Cooling System injection function loss"

・ The following tasks were performed during restoration of instruments within the main control room (MCR).

[Preparations toward venting]

・ Accident Management (AM) operation procedures were submitted to the Shift Supervisor chair in the MCR and its contents were checked. Checking began for the location of valves and which valves would be needed for venting, using the valve checklist.

・ The plant operation team began deliberations on venting procedures without power while looking at AM operating procedures.

・ The restoration team investigated the relevant diagrams and contacted contractors to confirm whether the type and structure of suppression chamber (S/C) vent valves (AO valve) needed for venting allowed manual operation. A manual operation handle was found on the diagrams for S/C vent valve (AO valve) bypass valves, confirming that they could be opened manually. This was reported to the MCR.

[Field dose starts to increase]

・ Operators went into the Reactor Building (R/B) to check IC shell side water level and the reactor water levels at 21:51 on March 11. Since their APD values rose to 0.8mSv in a short period of time, field checks were halted. This was reported to the MCR. The MCR temporarily restricted entry into the R/B and reported this to the station ERC.

・ The station ERC sent two members of the health physics team into the field to measure field radiation levels at 22:03 on March 11. This took place after receiving reports from the Shift Supervisor of APD value increase.

・ The two members of the health physics team that were sent into the field performed measurements in front of the Turbine Building 1st floor R/B airlock at 23:00 on March 11. Radiation levels were 1.2mSv/h in front of the Turbine Building 1st floor north side airlock and 0.5mSv/h in front of the Turbine Building 1st floor south side airlock. This was reported to the station ERC.

・ The dose within the R/B was predicted to be around 300mSv/h due to measured radiation levels. To ensure personnel safety, the Site Superintendent restricted entry into the R/B and contacted the MCR at 23:05 on March 11. Although reports were received that the IC was operating and the reactor water level was stable, the fact that radiation levels were rising led the Site Superintendent to doubt IC operation status and consider the possibility of some type of unusual occurrence in the reactor.

- The two members of the health physics team who had been performing field radiation level measurements put up “entry restricted” signs in front of the north side (23:33 on March 11) and south side (23:50 on March 11) airlocks, thus completing entry restriction measures.

[Dry Well pressure increase confirmed]

- In the MCR, the restoration team connected the small generator being used for temporary MCR lighting to the Dry Well (D/W) pressure gauge around 23:50 on March 11. They confirmed that display values were 600kPa [abs] and reported this to the station ERC.
- Due to the fact that the R/B radiation level was rising and D/W pressure was 600kPa, the Site Superintendent considered the possibility that the IC was not operating. Unusualness in the D/W pressure gauge was considered, but D/W pressure had already reached levels where venting would be needed. Therefore, the Site Superintendent ordered venting preparations to advance at 00:06 on March 12.

○Details of activity after “March 12 00:06 Site Superintendent ordered to advance preparations (...) due to possibility of dry well pressure exceeding 600kPa [abs]”

[Specific venting procedure deliberation commencement]

- Confirmation of specific procedures, such as valve operation methods/procedures, began within the MCR. This was performed using materials such as piping and instrumentation diagrams, AM operation procedures, valve diagrams and acrylic boards displaying system diagrams.
- An application for venting implementation was submitted to, and approved by, the Prime Minister, Minister of Economy, Trade And Industry (METI), and NISA around 01:30 on March 12. It was reported that the head office ERC stated, “Various methods should be used to operate the MO and AO valves for venting. The Minister of METI and TEPCO will make an announcement on venting implementation at 03:00. Venting should be performed after the announcement is made.”

[Continued deliberation of venting procedures, preparations toward implementation]

- Venting field operation wrench time evaluation results were reported to the station ERC at 02:24 on March 12. In the results it was stated that wrench time would be 17 min. (personal air supply would be 20 min., iodine tablets must be administered) at emergency response dose limits (100mSv) under a 300mSv/h environment.
- It was confirmed that D/W pressure reached 840kPa [abs] (max. operating pressure: 427kPa [gage][1]) at 02:30 on March 12.

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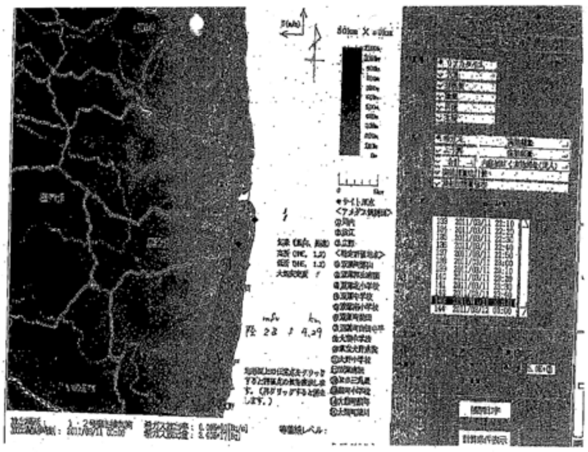
[1]Max. operating pressure 427 kPa [gage] is 528.3kPa [abs] under absolute pressure calculation (528.3kPa [abs] = 427kPa [gage]

- At 02:38 on March 12, the health physics team headed to the solid waste storage facility located on high ground and collected APD alarm setters. They began setting APD alarm values to 80mSv in preparation for work in a high radiation environment.
- While the Unit 1 field radiation level was high, this was not the case for Unit 2, and field vent valve operation was possible there. Therefore, it was decided at 02:34 on March 12 that Unit 2 venting was prioritized and that venting would be performed at 03:00. Preparations toward Unit 1 venting continued in the meantime.
- Since Unit 2 reactor core isolation cooling system (RCIC) operation was confirmed at 02:55 on March 12, Unit 1 venting was given priority instead.
- A press release regarding venting implementation was given with the Minister of METI being present at 03:06 on March 12. Although initial plans were to announce that priority would be given to venting implementation of Unit 2, due to the confirmation of Unit 2 RCIC operational status immediately before the press release, it was merely stated in the announcement that venting would be performed.

- An evaluation of exposure dose for the surrounding areas during venting was drafted in the head office ERC at 03:44 on March 12 and was shared with the station. This was reported to government agencies at 04:01. R/B dose measurements could not take place at the station. This was because the health physics team saw a white fog-like smoke when they opened the R/B airlocks for measurement, and thus, immediately closed the airlocks.


Dose evaluation due to the venting (based on prerequisites, does not reflect actual conditions)

- Meanwhile, due to a radiation level increase discovered by the health physics team while measuring doses within the MCR, the Shift Supervisor moved all operators within the MCR to the Unit 2 side around 04:00 on March 12, as radiation levels were lower there. It was around this time that the station ERC considered the possibility of fuel damage due to the way radiation levels had increased.
- The double automatic doors at the entrance to the seismic isolated building were shifted to manual opening/closing for open/close status management. This was done mostly by the support personnel from Kashiwazaki-Kariwa Nuclear Power Station (NPS).

+ 101.3kPa)

- Due to the risk of tsunami caused by aftershocks, the station ERC issued an order for prohibition of field work to the MCR at 04:30 on March 12.
- It was reported to the station ERC at 04:28 on March 12 that the Prime Minister would be arriving on the grounds via helicopter at 07:00. The health physics team began surveying the area between the seismic isolated building and the grounds to find a landing area for the helicopter. This was completed before the Prime Minister arrived.
- Since the exposure dose limits for employees performing field work was set at the statutory stipulated value of 100mSv, the station ERC delivered APDs with alarm values set at 80mSv to the MCR at 04:39 on March 12.
- Since contamination was seen in workers who returned to the seismic isolated building, at 04:57 on March 12, all personnel entering the field were ordered to put on "full face masks + charcoal filters + B equipment/C equipment/full body suits" at the seismic isolated building entrance. A similar order (put on "full face mask + charcoal filter + B equipment") was given to the MCR afterwards at 05:04.
- Since radiation levels rose within the MCR, operators had moved to the Unit 2 side. Upon receiving orders from the station ERC, the Shift Supervisor began selecting personnel to head into the field to perform venting. One by one, operators began raising their hands in a deathly silent MCR. This included younger operators as well. The Shift Supervisor did not consider it wise to send out younger operators into a field where radiation levels were high and exact conditions remained unknown. Three teams were set up, in formations to evenly distribute the Shift Supervisor and Deputy Supervisors. The framework of these teams consisted of groups of two personnel, in consideration for the difficulty of performing work alone amidst a pitch black field and to allow retreat in case of aftershocks and predicted high radiation levels. Since there were no tools for communication with the field and there was risk that rescue could not be performed during emergency evacuation, it was decided that one team would go into the field at a time, with the next team heading out after the previous team had returned to the MCR.
- Operators gathered as much of the equipment needed for venting (e.g., fireproof suits, personal air supplies, APDs, survey meters, flashlights), from areas such as the S/B 1st floor and break rooms, where tsunami debris was scattered. Items such as valve operation order, torus room valve distribution, and valve height were repeatedly confirmed in preparation for venting. They made preparation for station ERC orders on venting implementation.
- It was confirmed at 06:33 on March 12 that evacuation from Okuma town toward Miyakoji was being deliberated.
- The Minister of METI issued an instruction for manual venting to be performed (prioritize

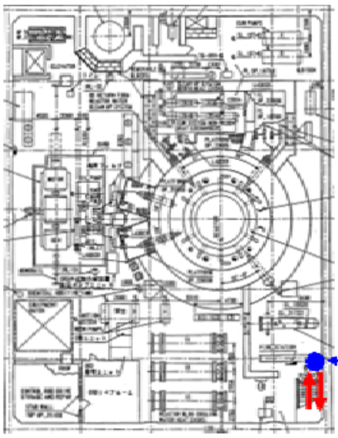
venting over power restoration) at 06:50 on March 12. This information was shared via teleconferencing at 06:59 of the same day (order document was received later).

- The helicopter carrying the Prime Minister and about 10 other persons landed on the grounds of Fukushima Daiichi NPS at 07:11 on March 12. They, wearing work clothes, were transported to the seismic isolated building via bus.
- Although there were no workers waiting for body surveys near the seismic isolated building 1st floor entrance, contractor workers and female employees who were unable to return home on March 11 had assembled there to evacuate to a shelter.
- The health physics team, which was in charge of performing body surveys at the seismic isolated building entrance, attempted to perform a body survey on the Prime Minister as he entered the seismic isolated building. Right as they started, they were asked, "What are you doing?" Despite explaining that they were performing a body survey, the same question was asked again, and the team was forced to abandon their efforts because the atmosphere was such that the body survey could not be continued. All of the persons were then escorted to the seismic isolated building 2F meeting room.
- Around 08:00 on March 12, six additional APDs with alarms set for 80mSv were delivered from the seismic isolated building to the MCR.
- The Site Superintendent issued an instruction at 08:03 on March 12 that the target time for Unit 1 venting operation would be 09:00.
- Due to the possible effects that venting implementation would have on area residents, it was necessary to confirm local resident evacuation status. In addition to the evacuation status of the 3km radius area for which an evacuation order had been issued, the local resident evacuation status for Okuma town (section of Kuma region), which lay on the south side of the station, was checked upon considering wind direction. TEPCO employees dispatched to the Okuma town hall reported to the station ERC at 08:27 on March 12 that some residents had not yet evacuated.
- Fukushima Prefecture was notified at 08:37 on March 12 that preparations toward venting with a target time of 09:00 were underway. It was arranged that the evacuation status would be confirmed before performing venting.
- Evacuation of Okuma town (section of Kuma region) was confirmed at 09:02 on March 12. Fukushima Prefecture was notified at 09:03 that a press release on venting would be issued at 09:05 and venting would be performed afterward.

○**<u>Details of activity after "March 12 09:04 Operators headed into the field to perform venting operation"</u>**

[PCV vent valve (MO valve) opening]

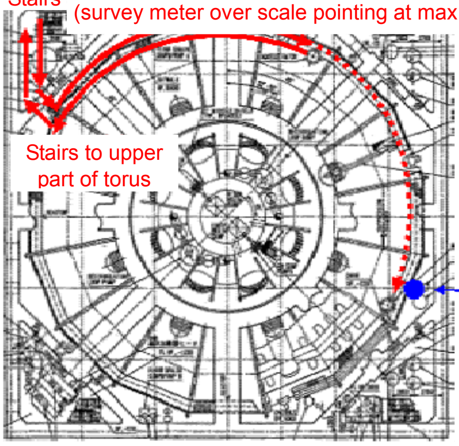
- Two operators from Team 1 headed for the R/B 2F at 09:04 on March 12 to manually open the PCV vent valve (MO valve). They wore fireproof suits, personal air supplies, and APDs, and carried flashlights since the field was pitch black. Since radiation levels were high at the R/B north side airlock, the south side airlock was used to enter the R/B. The PCV vent valve (MO valve) located 3m above the stairs on the southeast side of the R/B 2F was manually opened to 25% at 09:15, as per procedures. The operators then returned to the MCR. Their exposure dose was approx. 25mSv.



R/B 2F

[S/C vent valve (AO valve) bypass valve opening]

- Team 2 headed for the R/B B1F torus room to manually open the S/C vent valve (AO valve) bypass valve. They left the MCR at 09:24 on March 12. After entering the torus room, their dosimeter readings went off the charts about halfway through the hallway (catwalk). Due to the risk of exposure to doses exceeding the dose limit of 100mSv, they headed back to the MCR at 09:32.
- Since radiation levels were not at those where work could be performed, Team 3 was forced to cancel their work. They reported this to the station ERC.
- It was later confirmed that the exposure amount exceeded the legally stipulated 100mSv for one of the operators who had performed field operations. The head office issued an order that all relevant organizations be contacted and that the operator in question receive medical diagnosis (the operator was transported to the off-site center on the evening of March 12 since he/she was feeling ill. The physician's diagnosis was exhaustion, not exposure).



R/B B1F


Catwalk (Unit 5, with light)

With no lighting and only flashlights to guide them, operators headed into total darkness toward the AO valve. However, they were forced to turn back due to radiation level increase.

[Deliberating S/C vent valve (AO valve) large valve opening methods]

- Since the S/C vent valve (AO valve) bypass valve could not be manually opened in the field, the restoration team began searching temporary compressors and deliberating connection areas. This was done to secure the necessary pressurized air for S/C vent valve (AO valve) large valve remote operation.

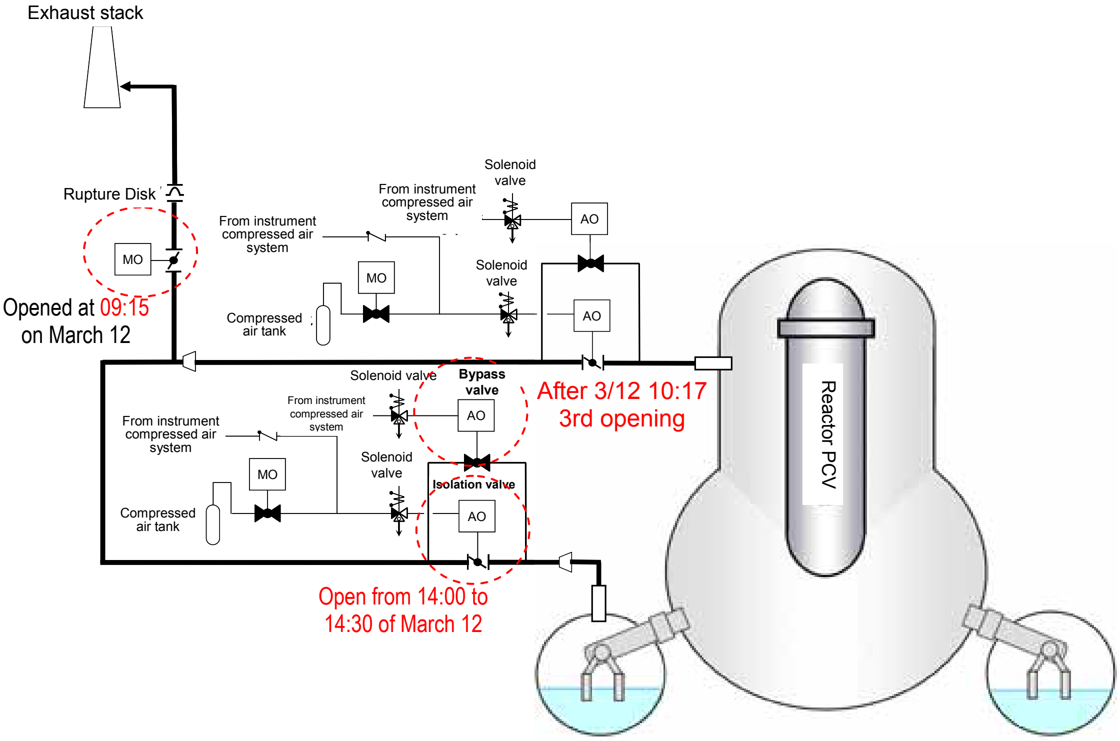
[Remotely opening the S/C vent valve (AO valve) bypass valve]

- Gambling on pressure remaining within the Instrument Air (IA) system, S/C vent valve (AO valve) bypass valve opening operation was performed from the MCR a total of three times (at 10:17, 10:23, and 10:24 on March 12). This was done by exciting the S/C vent valve (AO valve) bypass valve solenoid valve with the small generator being used for temporary lighting. It could not be confirmed whether the valve actually opened.
- Since radiation level increase was confirmed in the vicinity of the station main gate and nearby monitoring posts at 10:40 on March 12, the station ERC believed it highly likely that radioactive materials had been released due to venting. However, since radiation levels dropped at 11:15, the possibility arose that venting was not sufficiently effective.

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

- While searching for temporary compressors, the restoration team received word that the contractors on-site had them. Therefore, the restoration team began searching for the contractor office. The piping and instrumentation diagram was used to deliberate connection areas, and the copper pipe header in the nitrogen gas supply panel instrumentation rack outside the R/B truck bay was chosen as an installation area. Since the temporary compressor could not be connected without an adapter, a reference photo was taken of the area in the field, and operators returned to the station ERC.
- While searching for an adapter, the temporary compressors were found in the contractor offices around 12:30 on March 12. Those compressors were transported via crane truck. Due to high radiation levels, the compressors were installed near the liquid nitrogen tanks outside the R/B truck bay. After being connected to the copper pipe header in the instrumentation rack inside the liquid nitrogen gas supply panel, the temporary compressor was activated around 14:00.
- Since D/W pressure drop was confirmed at 14:30 on March 12, this was deemed to be a “release of radioactive materials” due to venting.

D/W Pressure 750kPa[abs]→580kPa[abs](14:50)



Valves operated in vent line configuration

End

Timeline of major events at Fukushima Daiichi Nuclear Power Station Unit 2 from the occurrence of the earthquake until March 15 (Tue.)

March 11, 2011 (Fri.)

14:46 **Tohoku-Chihou-Taiheiyo-Oki Earthquake occurred.** Level 3 state of emergency automatically issued.

14:47 **Reactor entered automatic scram,** main turbine automatically shut down, Emergency Diesel Generators automatically activated.

14:50 Reactor Core Isolation Cooling System (RCIC) manually activated.

14:51 RCIC automatically shut down (reactor water level high).

15:01 Reactor confirmed to be subcritical.

15:02 RCIC manually activated.

15:06 Emergency Disaster Countermeasures Headquarters established at headquarters (for understanding earthquake damage status and restoring power)

15:27 First tsunami wave arrived.

15:28 RCIC automatically shut down (reactor water level high).

15:35 **Second tsunami wave arrived.**

15:39 **RCIC manually activated.**

15:41 Station Black Out (SBO)

15:42 **Situation (SBO) deemed to fall under Article 10, Section 1 of the Act on Special Measures Concerning Nuclear Emergency Preparedness (hereinafter referred to as "Nuclear Emergency Act"), and government agencies were notified.**

15:42 Level 1 state of emergency for nuclear disasters issued. Emergency Response Center (ERC) established (joint headquarters with Emergency Disaster Countermeasures Headquarters).

Around 16:00 **On-site road soundness checks began.**

Around 16:00 **Power source facility (off-site power) soundness check began.**

16:10 **Headquarters Distribution Department ordered all stations to secure high/low voltage power supply cars and confirm transport routes.**

16:36 **Situation (Emergency Core Cooling System (ECCS) cooling water injection function loss) was deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to reactor water level being unable to be confirmed and injection status being unclear. Notifications made to**

government agencies at 16:45.

16:36 Level 2 state of emergency issued.

Around 16:50 High/low voltage power supply cars sent from all stations to Fukushima Prefecture in turn.

17:12 Site superintendent ordered to begin deliberation on reactor injection methods using Fire Protection System (FP) lines installed as an Accident Management (AM) measure, as well as fire engines.

Around 18:00 Power source facility (Electrical Power Distribution System) soundness checks began.

Around 19:00 Gate between Units 2 and 3 opened, securing vehicle travel routes to Units 1 to 4.

19:24 On-site road soundness check results reported to the ERC at the power station.

20:47 Temporary lighting turned on in the Main Control Room (MCR).

20:50 Fukushima Prefecture ordered evacuation of residents within a 2km radius of Fukushima Daiichi Nuclear Power Station (NPS).

20:56 Power source facility (off-site power, Electrical Power Distribution System) soundness check results reported to the ERC at the power station.

21:02 Since reactor water level was unclear and status of reactor injection with RCIC could not be confirmed, government agencies were notified that reactor water level could reach the top of the active fuel (TAF).

21:13 Time of TAF reached assessed as 21:40, and government agencies were notified.

21:23 Prime Minister ordered evacuation of residents within a 3km radius of Fukushima Daiichi NPS, and retreat to indoor areas for residents within a 3km to 10km radius of said NPS.

21:50 It was re-assessed that it will take time until TAF is reached, due to reactor water level being confirmed at TAF +3,400mm, and government agencies were notified at 22:10.

Around 22:00 Arrival of one high voltage power supply car of the first group of Tohoku Electric confirmed.

March 12, 2011 (Sat.)

00:30 Evacuation as per order from the central government for residents confirmed to be completed (evacuation for residents within a 3km radius of Futaba and

Okuma Towns confirmed to be completed, re-checked at 01:45)

01:20 Diesel-driven fire pump (DDFP) confirmed to have shut down.

Around 01:20 Arrival of one TEPCO high voltage power supply car confirmed.

Around 01:30 Request for approval of venting at Units 1 and 2 submitted to Prime Minister, Minister of Economy, Trade and Industry, and NISA, and were granted.

02:55 ERC at the power station confirmed that RCIC was operating.

03:06 Press release on implementation of venting.

03:33 Results of simulated venting exposure assessment notified to government agencies.

04:20 RCIC water source switching began.

04:55 Site radiation level increase (near main gate: 0.069μSv/h (04:00) → 0.59μSv/h (04:23)) confirmed, and government agencies were notified.

05:00 RCIC water source switching completed.

05:44 Prime Minister ordered evacuation of residents within a 10km radius of Fukushima Daiichi NPS.

06:50 Minister of Economy, Trade and Industry issued legally mandated order for venting (manual venting).

07:11 Prime Minister arrived at Fukushima Daiichi NPS.

08:04 Prime Minister departed from Fukushima Daiichi NPS.

Around 10:15 The 72 power supply cars dispatched by TEPCO and Tohoku Electric confirmed to have arrived in Fukushima (high voltage power supply cars: 12 to Fukushima Daiichi and 42 to Fukushima Daini; low voltage power supply cars: 7 to Fukushima Daiichi and 11 to Fukushima Daini).

Around 15:30 Routes assembled to supply power to Unit 1 MCC from high voltage power supply cars via the Unit 2 P/C. Power transmission to areas near the Unit 1 standby liquid control system (SLC) pump began and high voltage power supply car adjustments were completed.

15:36 Explosion occurred at Unit 1 reactor building (R/B).

16:27 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (1,015μSv/h) measured near monitoring post No. 4, and government agencies were notified.

17:30 Site superintendent ordered venting preparations to begin.

18:25 Prime Minister ordered evacuation of residents within a 20km radius of Fukushima Daiichi NPS.

March 13, 2011 (Sun.)

08:10 Primary Containment Vessel (PCV) vent valve (MO valve) opened.

08:30 High voltage power supply cars started up in an attempt to send power to Unit 2 P/C again, but failed due to overcurrent relay activation.

08:56 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (882μSv/h) measured near monitoring post No. 4, and government agencies were notified at 09:01.

10:15 Site superintendent ordered venting implementation.

11:00 Venting line (excluding rupture disk) assembly completed.

11:20 Press release on implementation of venting.

12:05 Site superintendent ordered to advance preparations for seawater use.

13:10 Batteries connected to safety relief valve (SRV) control panel, allowing opening operation with the operation switch.

14:15 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (905μSv/h) measured near monitoring post No. 4, and government agencies at 14:23.

15:18 Results of simulated venting exposure assessment reported to government agencies.

March 14, 2011 (Mon.)

02:20 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (751μSv/h) measured near main gate, and government agencies were notified at 04:24.

02:40 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (650μSv/h) measured near monitoring post No. 2, and government agencies were notified at 05:37.

04:00 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (820μSv/h) measured near monitoring post No. 2, and government agencies were notified at 08:00.

09:12 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (518.7μSv/h) measured near monitoring post No. 3, and government agencies were notified at 09:34.

11:01 Explosion occurred at Unit 3 R/B.

12:50 Solenoid valve excitation circuit of the suppression chamber (S/C) vent valve (AO valve) isolation valve discovered to have come loose and become closed.

13:05 Seawater injection line (including fire engines) assembly was restarted due to damage to fire engines and hoses rendering prepared injection line unusable.

13:18 Since reactor water level showed signs of dropping, it was notified to government agencies that preparations for reactor seawater injection operation would be performed immediately.

13:25 Situation (loss of reactor cooling function) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to reactor water level drop suggesting possibility of RCIC function loss, and government agencies were notified at 13:38.

15:28 Time of TAF reached assessed as 16:30, and government agencies were notified.

Around 15:30 Fire engines started up to perform reactor seawater injection.

16:34 Alongside starting reactor depressurization operations, start of seawater injection via FP lines was notified to government agencies.

17:17 Reactor water level reached TAF. Government agencies were notified at 17:25.

18:02 Reactor depressurization began (reactor pressure: 5.4MPa → 0.63MPa (19:03)).

18:22 Reactor water level reached TAF -3,700mm and fuel exposure was deemed to have occurred. Government agencies were notified at 19:32.

19:20 Fire engines being used for reactor seawater injection found to have stopped due to lack of fuel.

19:54 Reactor seawater injection using FP line via fire engine began (one unit started up at 19:54 and another at 19:57).

Around 21:00 S/C vent valve (AO valve) bypass valve opening operation took place. Venting line (excluding rupture disk) assembly completed.

21:20 Two SRVs were opened and it was confirmed that reactor water level had begun recovering. Government agencies were notified at 21:34 (as of 21:30, reactor water level was TAF -3,000mm).

21:35 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (760μSv/h) measured near the main gate, and government agencies were notified at 22:35.

22:50 Situation (abnormal PCV pressure increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to drywell (D/W) pressure exceeding maximum operating pressure of 427kPa [gage], and r government agencies were notified at 23:39.

23:35 Since S/C side pressure was lower than rupture disk activation pressure and D/W side pressure was rising, it was decided to open the D/W vent valve bypass valve to perform venting.

March 15, 2011 (Tue.)

00:01 D/W vent valve (AO valve) bypass valve was opened, but found to be closed again several minutes later.

03:00 Since D/W pressure exceeded the design maximum operating pressure, depressurization and reactor injection operations were attempted. However, it was notified to government agencies at 04:17 that depressurization had not been fully effective.

05:35 Integrated Fukushima NPS Accident Response Headquarters established.

Around 06:14 Large collision noise occurred, accompanied by vibrations. Downscale of S/C pressure readings.

06:50 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (583.7μSv/h) measured near the main gate, and government agencies were notified at 07:00.

07:00 It was notified to government agencies that personnel would temporarily evacuate to Fukushima Daini, save the minimum needed for monitoring and work activities.

08:11 Situation (abnormal radioactive material release due to fire/explosion) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (807μSv/h) measured near the main gate, and government agencies were notified at 08:36.

08:25 Steam-like white smoke found rising from the R/B 5F area walls, and government agencies were notified at 09:18.

10:30 Legally mandated order issued by the Minister of Economy, Trade and Industry (perform reactor injection as soon as possible and perform D/W venting as needed).

11:00 Prime Minister ordered retreat to indoor areas for residents within areas between a 20km and 30km radius from Fukushima Daiichi NPS.

16:00 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (531.6μSv/h) measured near the main gate, and government agencies were notified at 16:22.

23:05 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (4,548μSv/h) measured near the main gate, and government agencies were notified at 23:20.

End

Response status concerning Fukushima Daiichi Nuclear Power Station Unit 2 cooling water injection

○Details of activity from "March 11 16:36 Determining and notifying Emergency Core Cooling System injection function loss"

[Alternate injection measure deliberations and preparations]

- The Site superintendent believed that extremely harsh severe accident response would have to be carried out from then on at 17:12 on March 11. He ordered deliberation on use of alternate injection measures (Fire Protection System (FP), make up water condensate system (MUWC)) installed as Accident Management (AM) and fire engines.
- AM operating procedures were opened on the Shift Supervisor seat in the Main Control Room (MCR) and alternate injection lines confirmed. At the same time, the search for instruments capable of confirming the reactor water level took place in the MCR in total darkness. Operators found that indicators were on in the trip channel panel behind the main control panels at 17:35 on March 11, where they confirmed that the reactor water level was stabilized at 80%. The Shift Supervisor reported to the station ERC that the reactor water level was stabilized at 80%. Batteries were later lost, and the reactor water level could no longer be confirmed at 18:12.
- Upon considering Unit 1 radiation levels, operators decided to line up an alternate reactor injection line using the FP line via residual heat system (RHR) before radiation levels could increase. After configuration of the Unit 1 alternate injection line was completed, Unit 2 line up work began around 21:00 on March 11. Since loss of power meant operations could not be performed from the MCR, operators went to the Reactor Building (R/B) to manually open four valves (including RHR). They did so in total darkness, with only flashlights for light, while wearing full face masks. Alternate injection line configuration was completed during March 11.
- Particularly for the RHR intake valve installed on piping approx. 60cm in diameter, the

RHR injection valve installed on piping approx. 60cm in diameter (Unit 5, with light)

Example of RHR injection valve operation (Unit 5, with light)

(Manual operation handles were very rigid and hard to operate, with work taking place in confined areas.)

manual operation handles approx. 60cm in diameter were very rigid and hard to move. It was also an isolation valve where valve stem strokes were long, performed in a confined area atop a ladder. Ten operators turned the handle in shifts, performing opening operations in approx. one hour (normally motor-driven via MCR operation switch, requiring approx. 24 sec. to fully open).

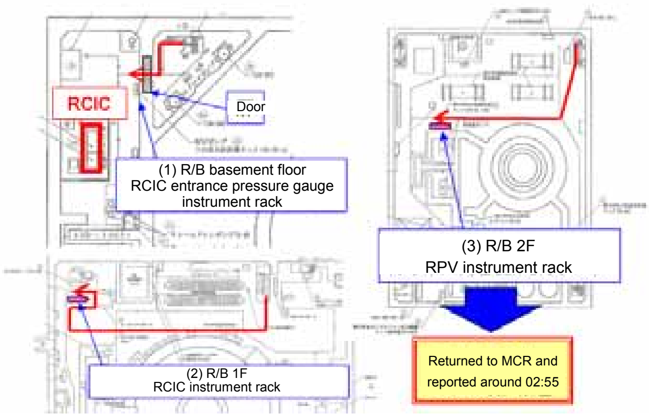
・ The MCR Diesel Driven Fuel Pump (DDFP) status indicating light was off. The Turbine Building (T/B) basement floor where the DDFP was installed was submerged in water approx. 60cm high. Although the FP pump room could not be entered, operators confirmed that the DDFP was operating via smoke generated from outdoor DDFP exhaust ducts. Exhaust duct smoke generation check was continued from then on, and operators confirmed that the DDFP had shut down due to exhaust duct smoke generation stopping at 01:20 on March 12.

[Reactor Core Isolation Cooling System status check]

・ Operators headed into the field to check reactor core isolation cooling system (RCIC) operation status around 01:00 on March 12. Operators wore personal air supplies and carried flashlights during field checks. Since the special shoes used when entering the controlled area had been washed away by flooding, the long boots normally used for outdoor patrols were worn instead. Flooding water levels in front of RCIC room doors on the R/B basement floor were already so high that operator long boots were almost submerged. Water came rushing out when RCIC room doors were opened, so they were immediately closed. Although the room itself could not be entered, operators heard a keen metallic noise when they were there. Since the rotating parts could not be checked, operation status could not be determined. As station wireless phone systems could not be used, reports were given after returning to the MCR.

Personal air supply

・ Operators headed toward the RCIC room again to check RCIC operation status at 02:12 on March 12. Water levels in front of the RCIC room doors had risen, and the RCIC room doors were opened since RCIC operation status had not yet been checked. Water flowed out slowly from the RCIC room as operators entered. They discovered that the pump suction pressure gauge in the RCIC suction pressure instrument



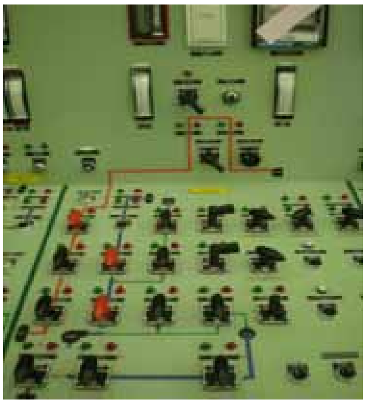
rack near the doors was shaking slightly, and also heard sounds of operation. Later, they discovered that RCIC discharge pressure was 6.0MPa at the RCIC instrument rack of the R/B 1F, and reactor pressure was 5.6MPa at RPV instrument rack of the R/B 2F. Since RCIC discharge pressure was higher than reactor pressure, they assumed that the RCIC was operating (functional). They returned to the MCR and reported to the station ERC at 02:55.

・ Field checks would normally take around 10 min. However, due to extraordinary factors (field being in total darkness, continued large tsunami alert in effect, frequent aftershock occurrence, equipment of personal air supply), it took approx. one hour.

[High Pressure Coolant Injection (HPCI) status check]

・ The HPCI could not be started up since DC power needed for operation control was lost. All HPCI condition indicator lamps at the MCR were off.

・ The restoration team began post-tsunami/earthquake status checks of the power source equipment in the field around 18:00 on March 11. The S/B basement floor where DC power equipment was installed was submerged in water approx. 1.5m in height, so inspection had to be cancelled.



HPCI control panel (photo taken at later date)
At the time, all condition indicator lamp were off

○Details of activity after "March 12 02:55 Station ERC confirmed that RCIC was operating"

[RCIC water source switching]

・ Two operators who were checking outdoor status checked the water level gauge installed at the Condensate Storage Tank (CST) (water source for RCIC). Tank water levels had dropped below the halfway point. Operators discussed this with the Shift Supervisor. It was decided that loss of CST water had to be avoided since CST water level was already dropping and it would be the water source for equipment used in later alternate injection. They considered raising S/C water level as well. It was decided that

RCIC (Unit 5, with light)

The silver part in the middle (heat insulation) is the turbine and the green part towards the back is the pump. There were many pipes and support beams in the room. Work and movement was performed with only flashlights for light and with water covering the floor.

the water source would be switched from CST to suppression chamber (S/C) to keep reactor injection via RCIC going. Four operators put on radiation protection clothes for the contamination level and full face masks before heading to the R/B basement floors at 04:20 on March 12.

- Operators headed to the torus room on the R/B basement floor to confirm whether the test line test valve was open. This was done to ensure that S/C water did not flow into the CST via test line (CST return line) when the water source was switched to S/C.
- Operators entered the torus room and arrived at the test line test valve after travelling across the catwalk in total darkness, lit only by flashlights. It was confirmed that the openness gauge display for said valve was at 0%, and was completely closed.
- Operators then moved on to the RCIC room on the R/B basement floor, where the three valves that needed to be operated to switch water sources were located. Lighting the way with flashlights, they entered the RCIC room. The RCIC was humid and sauna-like, with water on the floor nearly enveloping the long boots that the operators wore.
- Lights had gone out in the RCIC room, and it was in total darkness. The sounds of RCIC operation reverberated throughout the room. Using flashlights for light, operators manually operated the three Motor Operated (MO) valves in order to complete a line where water source was S/C instead of CST. The stroke of valve stems for each valve was long, making manual operation handles rigid and hard to move. Since the area of operation was located high up where there was no scaffolding, operators had to stretch out their arms while on a ladder to turn the handle.
- One operator was left at the RCIC suction instrument rack to monitor pump suction pressure gauge. Two operators worked in turns to operate the valve. The last operator handled lighting, as well as communication with the operator in charge of pressure monitoring. Operations were carefully carried out to ensure the RCIC did not shut down, and were completed at 05:00 on March 12 (normally, switching operation would be motorized, performed via MCR operation switch, and be completed in about 5 min.).

[RCIC operational state confirmation]

- Since reactor injection equipment that did not require power sources (DDFP, HPCI) could not be used, the operational state of the only remaining injection equipment (RCIC) was regularly checked by operators.
  - After checking parameters at the instrument rack on the R/B 2nd floor, operators travelled halfway to the R/B basement floor stairs to confirm whether sounds of operation could be heard around 21:00 on March 12.
  - Discharge pressure was confirmed to be between 6.0MPa and 6.4MPa via the RCIC instrument rack on the R/B 1st floor, reactor pressure was confirmed to be 6.1MPa via

RPV instrument rack on the R/B 2nd floor, and RCIC discharge pressure was confirmed to be higher than reactor pressure at 10:40 on March 13.

- It was confirmed that discharge pressure was 6.3MPa via the RCIC instrument rack on the R/B 1st floor and that RCIC was still operating at 13:50 on March 13.

[Preparations for seawater injection and reactor depressurization via Safety Relief Valve (SRV)]

- Ten 12V batteries would be needed as a 125V DC power source to drive the SRV for Unit 3 reactor depressurization before performing injection. The station ERC called on TEPCO employees at the seismic isolated building to gather batteries from their personal vehicles around 07:00 on March 13.
- The station ERC also called for TEPCO employees to provide batteries for Unit 2, since they would be needed in the future. The required number of personnel was gathered, and they each removed the battery from their personal vehicles. These batteries were collected in front of the seismic isolated building.
- Five members of the restoration team carried the collected batteries via private vehicles to the Unit 3 MCR. Afterwards, they returned to the seismic isolated building to begin transporting the batteries to Unit 2. When they reached the entrance of Units 1 and 2, an order for temporary evacuation was given so Unit 3 PCV venting could be performed. The operators went into standby at the station main gate. They confirmed that smoke billowing from the main stack for Units 3 and 4 was being blown away by the wind.

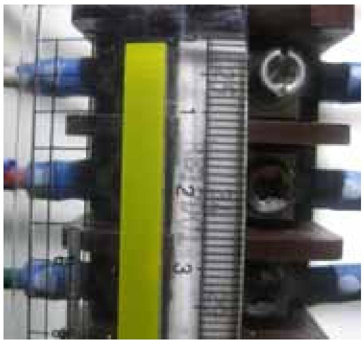
Behind the control panel
(photo taken at a later date, with light)

- Five members from the restoration team transported batteries to the Unit 2 MCR using personal vehicles after Unit 3 PCV venting was performed.
- At 12:05 on March 13, the Site superintendent ordered preparations to proceed for use of seawater in reactor injection. A lineup using the Unit 3 backwash valve pit as a water source was advanced prior to RCIC shutdown, so that the switch to seawater injection could take place. The fire brigade distributed fire engines and installed hoses. These fire engines were started up as part of preparations to ensure seawater injection could begin.

Ten 12V battery parallel[in series]
(photo taken at a later date, with light)

Wiring and terminal connectors were affixed with electrical tape. Risk of electric shock and short circuiting were present. Sparks were generated, and some terminals melted.

- The restoration team connected batteries to the MCR SRV control panels at 13:10 on March 13. This allowed one SRV1 valve to be opened via the SRV control panel operation switch. This was the same method used at Unit 3, where reactor depressurization had been maintained.
  - Although temporary lighting had been installed within the MCR, light did not reach the work area (behind the control panels) and this location remained in total darkness. Terminal and cable numbers/wiring diagrams were hard to see, even when using flashlights. Operators wore full face masks and rubber gloves while working in this confined area.
  - Ten 12V batteries were connected in series to provide the DC power needed to operate the SRV. Cutting wires and removing covering was delicate work. This work carried the risk of electric shock and short circuiting, since wires and terminal connectors had to be directly affixed to each other using electrical insulating tape. With full face masks on and lit only by flashlights, the operator's field of vision was severely limited. Electrical insulating tape stuck to their rubber gloves. Sparks were generated when wires came into contact with the batteries, and some of the terminals melted.



Terminal block (photo taken at later date)
Wires were connected to a terminal block approx. 1cm wide

  - Since work was carried out while wearing two pairs of rubber gloves, screwing in screws with screwdrivers proved difficult. Caution had to be exercised to ensure that the small, hard-to-grasp screws were not dropped.

○**<u>Details of activity after "March 14 11:01 Explosion occurred at Unit 3 Reactor Building"</u>**

[Post-explosion response status]

- It was reported that the Unit 2 reactor water level began dropping and reactor pressure began rising around 12:50 on March 14.
- Field work had been halted after the explosion, but the Site superintendent issued an instruction for Unit 2 response at 13:05 on March 14, while the effects of the second explosion (following explosion at Unit 1) were still being felt. "Unit 2 reactor water level drop was confirmed. Top of Active Fuel (TAF) will be reached around 16:00 if this continues. Will line up reactor injection and restore Unit 3 backwash valve pit (water source) by 14:30. Care must be taken to prevent explosions. Equipment may have been damaged by explosion at Unit 3. Do not assume they are usable."
- The Site superintendent requested the headquarters ERC to hurry its response (opening

Unit 2 blowout panel or opening holes in R/B) at 13:17 on March 14.

- Reports were received at 13:30 on March 14 that the Unit 2 blowout panel was open after the explosion at Unit 1. The Site superintendent ordered reconfirmation to check the facts. Two members of the restoration team headed into the field.
- It was reported to the station ERC at 14:04 on March 14 that emergency exposure dose levels would be raised to 250mSv following adjustments between the headquarters and NISA.
- It was reported at 14:50 on March 14 that the Unit 2 R/B seaside blowout panel was open.[1]

[Seawater injection line reassembly]

- Field work was restarted upon Site superintendent orders at 13:05 on March 14.
- The road between Units 2 and 3 could not be travelled by car due to piles of scattered debris from the explosion at Unit 3. Therefore, the restoration team and contractors began clearing the debris using heavy machinery. Radiation levels were extremely high and wrench time was limited. Work was carried out in shifts, allowing the road between Units 2 and 3 to become traversable around 15:00 on March 14.
- The fire brigade headed into the field to perform field checks, amidst extremely high radiation levels. Although preparations were completed for the injection line, the fire engines and hoses near the Unit 3 backwash valve pit had been damaged and were rendered unusable. There was also explosion debris scattered within the Unit 3 backwash valve pit, which was the water source for the injection line.
- Fire engines that had been providing seawater from the shallow draft quay to the Unit 3 backwash valve pit were unaffected by the explosion, and thus, were still usable. It was decided that these fire engines would be used to inject seawater into the reactors at Units 2 and 3, using the shallow draft quay as a water source. Replacement of damaged hoses and alternate injection line assembly was advanced.
- The RCIC was deemed to have lost its function due to the reactor water level dropping at 13:25 on March 14. Based on the current situation, it was estimated that TAF would be reached around 16:30. Reactor pressure showed signs of increase, staying between approx. 7.0MPa to 7.4MPa. Reactor seawater injection preparations were continued. Connection of the fire engine to the FP intake was completed at 14:43.
- Aftershocks with hypocenters offshore Fukushima occurred from 15:00 to 16:00 on March 14.[2] Work was advanced during this time, and the fire engine was started up around 15:30 on March 14. Preparations allowing injection to begin after reactor depressurization were now in place.

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[1] Later surveys led to the assumption that this was likely caused by the effects of the explosion at Unit 1.

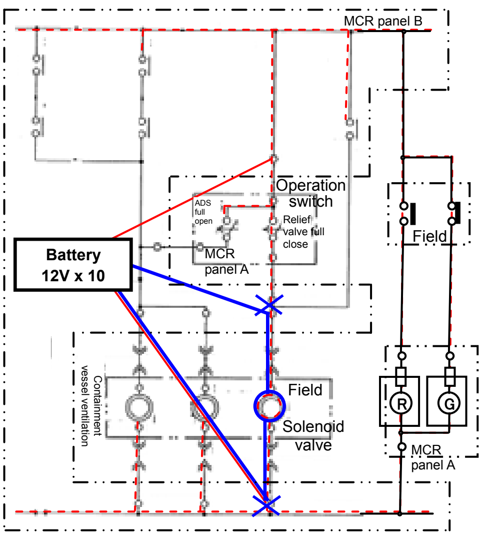
[2] Shindo 3 / M6.3 at 15:13 offshore Fukushima; Shindo 3 / M5.3 at 15:18 offshore Fukushima.

[Reactor depressurization]

- Reactor depressurization via SRV opening operation would be needed to allow injection via fire engines. The SRV opening operation could take place by batteries, which were prepared on the previous day.
- S/C status as of 12:30 on March 14 was 486kPa [abs] (S/C pressure) and 149.3ºC (S/C temp.). The station ERC first decided to ensure an exit route for S/C pressure. This was because SRV exhaust steam would not be condensed in the S/C if the SRV were opened, making it difficult to depressurize the reactor; also, there was risk of further S/C pressure and temp. increase leading to damage. It was also decided that PCV venting preparation would be carried out before opening the SRV to depressurize the reactor, then performing seawater injection. This decision was made to ensure that depressurization injection was definitively carried out.
- Initially, TAF reach time was predicted to be 16:30. TAF reach time was re-evaluated using the latest data at 15:57 on March 14, and the results gave a time of 17:30. This one hour increase led the station ERC to decide that venting preparations would be completed by 17:00, and then depressurization injection would begin. The Site superintendent ordered all personnel to pay extra attention to any details prior to this task.
- The NSC chairman contacted the Site superintendent, stating that depressurization injection should be prioritized over venting at 16:15 on March 14. After being contacted, the station ERC and headquarters ERC deliberated on a response. It was believed that securing a release route for S/C pressure would be vital in ensuring that depressurization was definitively performed. This was upon consideration of several factors, such as the leeway in time until the current reactor water level (TAF +1,000mm) reached TAF (predicted occurrence time of 17:30), a possible difficulty in reactor depressurization due to SRV exhaust steam refusing to condense, and a concern over the risk of damage posed by high temp./pressure. The policy (make preparations for venting before performing depressurization injection) was re-confirmed, and the NSC chairman was notified of these results.
- The restoration team advanced venting preparations in the MCR. Although the solenoid valve of the large S/C vent valve was excited at 16:21 on March 14, it could not be confirmed whether said valve opened due to the possibility that air compression via temporary compressor was not sufficient.
- It was believed that it would take some time until venting preparations were completed. Left unchecked, the reactor water level would drop and could pose a risk to fuel status. Therefore, the station ERC and headquarters ERC deliberated yet again, deciding to

prioritize reactor depressurization via SRV at 16:28. However, since venting preparations would also be necessary, the Site superintendent ordered reactor depressurization to be proceeded with alongside venting preparations.

- Sounds believed to be caused by steam escaping from the SRV due to reactor pressure increase echoed throughout the silent MCR. It was during this time that operators attempted SRV opening via the MCR operation switch at 16:34 on March 14, but this was unsuccessful.
  - The restoration team checked cable connection points for the SRV control circuit and the circuit diagram for SRV opening, connected them to another SRV, and attempted opening via the operation switch. Despite their efforts, this was also unsuccessful.
  - Connections were switched to yet another two SRVs, and opening was attempted via the operation switch. However, this was also unsuccessful.
  - All cables from batteries were temporarily removed, and were reconfigured into a series of ten batteries.
- Since opening via the operation switch was unsuccessful, the restoration team decided to narrow down the scope of power source at 18:02 on March 14. They connected cables directly to the SRV opening solenoid valve on SRV control circuit and attempted excitation. Reactor pressure finally began to drop when cables were connected to the fifth SRV, and thus depressurization began.



Example: SRV control circuit (SRV opening solenoid valve excitation method)

Red: Power supplied to entire circuit (incl. solenoid valve excitement) by setting operation switch to "on" position. Swift battery consumption.

Blue: Narrowed scope of power provision so only the solenoid valve is excited. ✕ shows where outside wire was lifted (removed).

[Seawater injection]

- Depressurization began at 18:02, yet reactor pressure did not fully drop. Therefore, two SRVs were opened, and reactor pressure began dropping again. Thus depressurization resumed (reactor pressure: 6.998MPa (16:34) → 6.075MPa (18:03) → 0.63MPa (19:03)).
- During this time, the fire brigade was forced to confirm fire engine operation status and perform refueling in shifts due to high field radiation levels making it impossible for them to stay. Refueling work had to be performed while the engines of the fire truck were left on, as to do otherwise would have caused reactor injection to halt. It was discovered at 19:20 on March 14 that the fire engine being used for seawater injection had stopped upon running out of fuel. Since the fuel supply truck loaded with light oil suffered a flat due to the effects of debris and could not be moved, the fire engine was manually refueled. Afterwards, reactor seawater injection from fire engines (one fire engine started up at 19:54 and another started up at 19:57 on March 14) via FP line began.

Fuel supply truck with flat tire (photo taken at later date)

- Reactor pressure rose around 21:00 on March 14. It was decided that another SRV would be opened and the solenoid valve was excited, but reactor pressure did not drop. When other SRV solenoid valves were excited, reactor pressure dropped and the reactor water level gauge (in downscale) display values simultaneously showed an increase at 21:20. Afterwards, the station ERC read off the reactor water level, reactor pressure, and D/W pressure values every few minutes. They continued reactor injection while paying extra attention to station status changes (see “Response status concerning PCV venting operation” for details).

[Evacuation of personnel who could return home and preparations toward evacuation of certain employees]

- Although reactor depressurization began at 16:34 on March 14, depressurization did not proceed. The reactor water levels continued to drop, although reactor injection was not being performed at the time.
- Since it was believed that the situation would worsen (e.g., radiation level increase) if reactor injection did not advance, the Site superintendent recommended evacuation of contractors not currently performing work. They did so upon consideration of the safety of contractor employees on standby in the seismic isolated building.

- In addition to contractors who wished to evacuate, certain employees (e.g., women and the ill) were transported to the off-site center via bus.

The headquarters and station ERCs believed that personnel (excluding those needed for station monitoring and restoration activities) would need to be evacuated, depending on how the situation progressed. Therefore, deliberations and preparations (e.g., evacuation area selection, bus distribution) toward evacuation began around 19:30 on March 14 (see ”Response status concerning Fukushima Daiichi Nuclear Power Station Unit 2 PCV venting operation” for details on the situation that led up to later temporary evacuation).

End

Response status concerning
Fukushima Daiichi Nuclear Power Station Unit 2
PCV venting operation

○Details of activity after "March 11 16:36 Determining and notifying Emergency Core Cooling System injection function loss"

・ It was discovered, through instrument restoration work, that the reactor water level was top of active fuel (TAF) +3,400m at 21:50 on March 11. While water levels were maintained, the reactor core isolation cooling system (RCIC) operational status was unclear. It was discovered that the Dry Well (D/W) pressure gauge on the Reactor Building (R/B) 2nd floor showed 141kPa [abs] at 23:25. Thus, pressure levels did not yet reach levels where venting operation would become necessary.

・ A plan to perform venting was suggested to, and accepted by, the Prime Minister, the Minister of Economy, Trade, and Industry, and NISA around 01:30 on March 12. It was reported that the head office ERC stated, "various methods should be used to operate the Motor Operated Valve (MO valve) and AO valve to perform venting. The Minister of Economy, Trade, and Industry and TEPCO will make an announcement regarding venting implementation at 03:00. Venting should be performed after the announcement is made."

・ Although Unit 1 radiation levels were high at 02:34 on March 12, the radiation levels at Unit 2 were not high. This meant that field vent valve operation was possible there. Therefore, it was decided that the venting operation at Unit 2 would be given priority, and this would be performed at 03:00.

・ Since the RCIC was confirmed to be operating at 02:55 on March 12, it was decided that venting at Unit 1 would be prioritized instead. The response toward performing venting at Unit 1 was proceeded with, while continuing monitoring of parameters at Unit 2.

○Details of activity after "March 12 17:30 Site superintendent ordered venting preparations to begin"

[Preparations toward venting]

・ Reactor injection via RCIC continued, and D/W pressure remained stable between approx. 200 to 300kPa [abs]. However, since it was predicted that the venting operation would become necessary in the future, deliberation toward venting lineup was proceeded with alongside those for Unit 3. It was decided that the valves needed to perform venting would be opened (excluding rupture disk), since field radiation levels were not high as well.

・ It was confirmed at 00:06 on March 12 that Unit 1 D/W pressure may have exceeded 600kPa [abs]. Therefore, deliberation on whether valves needed for venting could be opened manually and whether tools could be used to force them open was performed. These deliberations used the drawing of the valves, and took place alongside the commencement of specific preparations toward the venting operation implementation.

- Confirmation of operation methods for the valves needed for venting[1] took place using the results of the above, as well as various documents (e.g., piping and instrumentation diagrams, Accident Management (AM) operating procedures, Unit 1 venting operation procedures). Thus were venting procedures created. At the same time, the valve checksheet was used to confirm the vent valve positions in the field.
- In accordance with the order to "open valves needed for venting (excluding rupture disk)," the restoration team manually opened PCV vent valve (MO valve) on the Turbine Building (T/B) 2nd floor to 25% and also opened the existing air tank outlet valve on the R/B 1st floor to confirm that tank pressure remained. They then headed to the torus room on the R/B basement floor to check S/C vent valve (AO valve) status, but were forced to abandon checking the valve status since steam was being emitted from the torus room doors when they opened and the inside of the room itself was also very hot and could not be entered. Radiation levels there were not high.
- It was later decided to temporarily close the PCV vent valve (MO valve). Operators manually closed the valve in accordance with orders from the station ERC.

[PCV vent valve (MO valve) and large S/C vent valve (AO valve) opening]

- The D/W pressure gauge of the AM control panel at Main Control Room (MCR) was restored by the restoration team, allowing pressure to be confirmed as being 315kPa [abs] at 03:00 on March 13. S/C pressure gauge restoration was also attempted, but the indicator was not restored.
- Operators headed toward the R/B in order to manually open the PCV vent valve (MO valve). They wore the necessary equipment, such as full face masks, and carried flashlights with them. They opened the PCV vent valve (MO valve) to 25%, as per procedures, at 08:10 on March 13.
- The Site superintendent ordered venting implementation at 10:15 on March 13. The restoration team excited the solenoid valve of the large S/C vent valve (AO valve) using the small generator powering MCR temporary lighting as a power source, so the opening of large S/C vent valve could be performed.
- Configuration of the venting line (excluding rupture disk) was completed at 11:00 on March 13.

  (D/W pressure was lower than rupture disk activation pressure (427kPa [gage], yet venting

[1] PCV vent valve (MO valve) could be opened manually. S/C vent valve (AO valve) could not be opened manually.

did not occur. Vent valve was kept open while the D/W pressure was continued to be monitored.)

- In order to keep the large S/C vent valve (AO valve) open, it was decided that a temporary compressor would be installed in addition to existing air tanks. Procurement began afterwards. It was discovered via teleconferencing that temporary compressors could be provided from Fukushima Daini Nuclear Power Station (NPS) and Kashiwazaki-Kariwa NPS at 22:22 on March 13.
- Temporary compressors from Fukushima Daini NPS arrived at 01:52 on March 14. These were installed near the air tank of instrument compressed air system (IA) on T/B 1st floor, connected to the IA piping, and they began supplying air around 03:00. From then onward, fueling continued every few hours in a high dose field to keep operating the temporary compressor.
- While the RCIC remained operating over the long term and instrument restoration by the restoration team continued, S/C pressure gauge at the AM control panel was not showing. Therefore, the S/C pressure gauge at another control panel was restored. It was confirmed at 04:30 on March 14 that S/C pressure was 467kPa [abs], while S/C temp. was confirmed to be 146ºC at 07:00 on March 14.

○Details of activity after "March 14 11:01 Explosion occurred at Unit 3 Reactor Building"

[Impact of explosion]

- After the explosion, all workers (excluding MCR operators) stopped whatever tasks they were performing to evacuate to the seismic isolated building. Restoration could not be started, as all were busy confirming worker safety and performing field status checks.
- It was confirmed at 12:50 on March 14 that the excitation circuit of solenoid valve for the large S/C vent valve (AO valve) had come loose and the said valve had closed due to the impact of the explosion.
- D/W pressure was approx. 460kPa [abs], while S/C pressure was approx. 480 kPa [abs]. These pressure levels were below those requiring venting, and remained stable thereafter.

[Small S/C vent valve (AO valve) valve opening]

- After the evacuation order due to explosion was lifted, the reactor needed to be depressurized by opening the Safety Relief Valve (SRV) to allow reactor injection via fire engine. It was decided that the SRV would be opened for reactor depressurization after venting preparations, to ensure that depressurization injection was definitely effective by securing S/C pressure release routes, due to a concern over risk of damage caused by further S/C temp./pressure and possible difficulties in depressurization due to high S/C temp./pressure, meaning that steam would not be compressed in the S/C when the SRV was opened.

- The small generator being used for temporary lighting shut down due to excessive voltage around 16:00 on March 14. The solenoid valve could not be excited immediately, so another small generator was used to excite the solenoid valve and perform the large S/C vent valve (AO valve) opening operation.
- The initial predicted TAF occurrence time of approx. 16:30, which was predicted when RCIC function loss was deemed to have occurred at 13:25 on March 14, was re-evaluated using the latest data and the results showed that the new time was approx. 17:30, extending the deadline by one hour. Therefore, the station ERC decided that venting preparations would be completed by 17:00 before starting depressurization injection. The Site superintendent ordered strict attention to detail in performing these operations.
- At 16:15 on March 14, the Nuclear Safety Commission of Japan (NSC) chairman contacted the Site superintendent, stating that depressurization injection should be prioritized over venting. After receiving this contacting, the station ERC and the head office ERC deliberated on a response. It was believed that securing a release route for S/C pressure would be vital in ensuring depressurization injection was definitively performed. This was upon consideration of several factors, such as the leeway in time until current reactor water level (TAF +1,000mm) reached TAF (predicted occurrence time of 17:30), possible difficulty in reactor depressurization due to SRV exhaust steam refusing to condense, and a concern over risk of damage posed by high temp./pressure. The policy (make preparations for venting before performing depressurization injection) was re-confirmed, and the NSC chairman was notified of these results.
- At 16:21 on March 14, it could not be confirmed whether the large S/C vent valve opened due to the possibility that air compression via temporary compressor was not sufficient, although the solenoid valve was excited.
- It was believed that it would take some time until venting preparations were completed. Left unchecked, reactor water level would drop and could pose a risk to fuel status. Therefore, the station ERC and the head office ERC deliberated yet again, deciding to prioritize reactor depressurization via SRV at 16:28. However, since venting preparations would also be necessary, the Site superintendent ordered reactor depressurization to be proceeded with alongside venting preparations.
- Reactor depressurization operation via SRV began at 16:34 on March 14, but reactor pressure failed to decrease for some time. It finally began to decrease at 18:02.
- Since D/W pressure showed no signs of dropping, it was decided at 18:35 that venting line restoration work would continue for not only the large S/C vent valve (AO valve), but also the small S/C vent valve (AO valve) as well. The restoration team removed one of the

nitrogen tanks in the T/B 1F for use as a replacement air tank, since it was predicted that air tanks could be running low. Operators confirmed that the air tank outlet valve of AO valve drive air tank rack at the south side of R/B 1st floor was open and the air tank was not empty. Therefore, the nitrogen tank prepared as a replacement air tank was not used. Since it was confirmed that the air of large S/C vent valve (AO valve) was being compressed via air tanks and the temporary compressor, it was assumed that failure to open was caused by a solenoid valve malfunction (grounding).

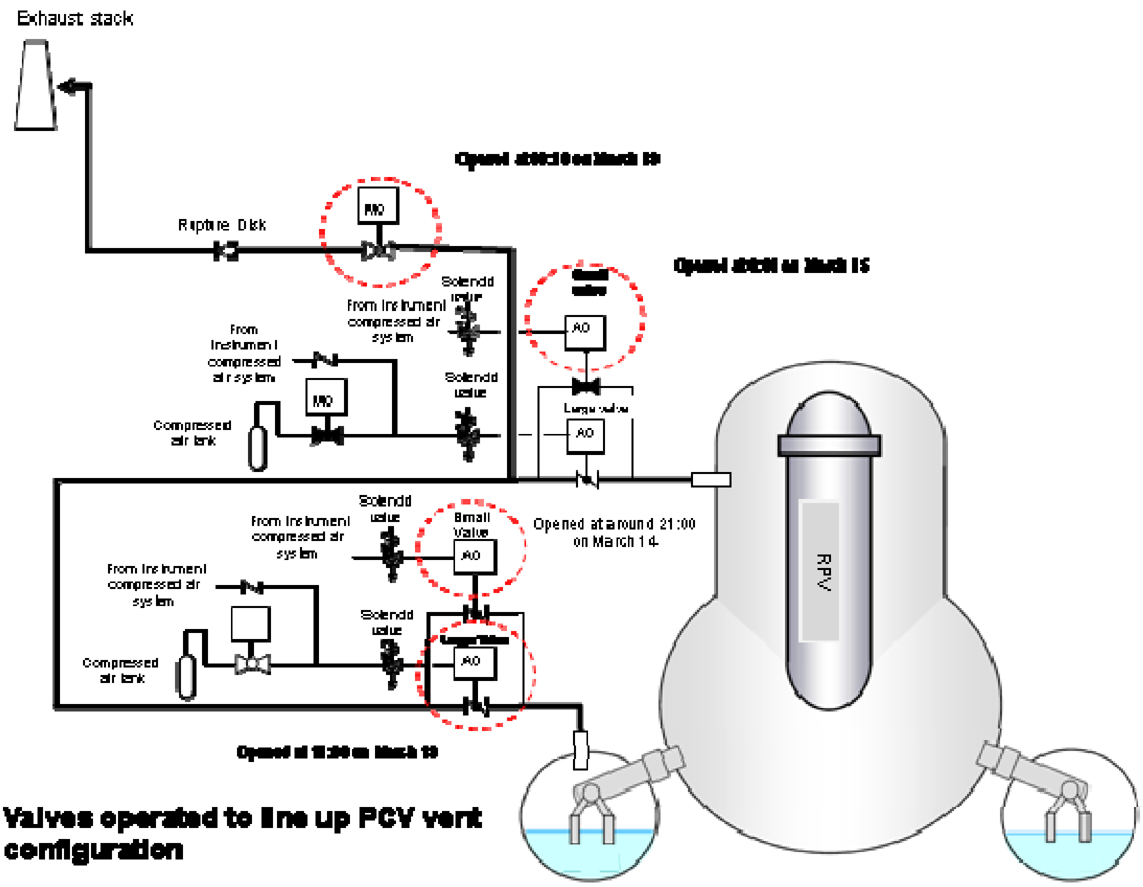
- The small S/C vent valve (AO valve) opened slightly due to excitation of the solenoid valve around 21:00 on March 14. Therefore, the venting lineup (excluding rupture disk) was completed at that time.
  (D/W pressure was lower than rupture disk activation pressure (427kPa [gage], yet venting did not occur. The vent valve was kept open while D/W pressure was continued to be monitored.)
- Reactor pressure and D/W pressure rose at 22:50 on March 14 (reactor pressure: 1.823MPa [gage], D/W pressure: 540kPa [abs]). Since D/W pressure exceeded max. operating pressure (427kPa [gage]), the situation was deemed to fall under “abnormal PCV pressure increase” provided in Article 15 of the Nuclear Emergency Act.
- Reactor pressure was 2.070MPa [gage] and D/W pressure was 580kPa [abs] at 23:00 on March 14. This reactor pressure increase led to the possibility that the SRV may have closed. Since batteries had not run out and it was believed that the SRV drive air had run out, operations to open another SRV began.
- Calls to report data took place every few minutes. Reactor pressure was 3.150MPa [gage] and D/W pressure was 700kPa [abs] at 23:25 on March 14.

[Opening the small D/W vent valve (only D/W pressure began rising)]

- It was confirmed that the S/C vent valve (AO valve) bypass valve had not opened at 23:35 on March 14. Although indicating values of D/W pressure gauge at the AM control panel was on an increasing trend, indicating values of S/C pressure at the AM control panel stabilized between approx. 300kPa [abs] to approx. 400kPa [abs], creating unevenness in pressure. Since S/C side pressure was lower than the rupture disk activation pressure and D/W side pressure was rising, a policy was decided where venting would be performed via opening of the small D/W vent valve (AO valve).
- Calls to report data were made at 23:30 on March 14 (reactor pressure: 1.913MPa [gage], D/W pressure: 700kPa [abs]). Continued SRV opening operation led to reactor pressure entering a downward trend, but D/W pressure was high and the situation still required venting. Thus, opening of the small D/W vent valve (AO valve) valve was hurried.
- Reactor pressure was 1.170MPa [gage]; D/W pressure was 740kPa [abs]; and S/C

pressure was 300kPa [abs] at 23:40 on March 14. D/W pressure still refused to decrease, and D/W pressure was 750kPa [abs] at 23:46.

- The only communication tools available between the station ERC and the MCR performing opening of the small D/W vent valve (AO valve) were two hotlines, and both were in use. One was being used to report data, while the other was being used to communicate orders from the station ERC. Small D/W vent valve (AO valve) opening operation was being performed in the MCR near the control panel, which was enveloped in total darkness because temporary lighting could not reach that area.
- The opening operation of the small D/W vent valve (AO valve) by exciting its solenoid valve was performed at 00:01 on March 15. However, it was confirmed to have closed several minutes later.
- Reactor pressure was 0.653MPa [gage] and D/W pressure was 740kPa [abs] at 00:05 on March 15, with D/W pressure showing no signs of decrease. Reactor pressure was 0.833MPa [gage], D/W pressure was 740kPa [abs], and S/C pressure was approx. 300kPa [abs] at 00:10, showing no changes. Since reactor pressure began to rise, the restoration team was ordered to prioritize SRV solenoid valve excitation work to continue attempting to open the SRV, and they continued performing response.
- Reactor pressure was 1.170MPa [gage] and D/W pressure was 735kPa [abs] at 00:22 on March 15. Reactor pressure entered a rising trend, and excitation of the next SRV solenoid valve was begun. However, reactor pressure rose to 1.823MPa [gage] at 00:45, and opening of the next SRV began.
- When the SRV solenoid valve was excited at 01:10 on March 15, reactor pressure began to drop. D/W pressure remained unchanged at approx. 730kPa [abs], while S/C pressure remained stable at approx. 300kPa [abs]. Reactor pressure later stabilized at approx. 0.63MPa [gage], but reactor pressure entered a rising trend at 02:22 and rose to 0.675MPa [gage]. Therefore, excitation of the next SRV solenoid valve began. D/W pressure rose slightly, becoming 750kPa [abs] at 02:45.



Valves operated to line up PCV vent configuration

- The restoration team, which had been performing response in the MCR since the evening of March 14, had been performing the SRV opening operation to perform depressurization to accompany reactor pressure increase, and the vent valve opening operation to perform depressurization to accompany D/W pressure increase. In accordance with station ERC orders based on station status, they performed reactor pressure stabilization via keeping the SRV open and response to line up PCV vent configuration. They did so while performing cable connection work wearing full face masks and rubber gloves, with only flashlights for lighting. Afterwards, they determined SRV status via reactor pressure increase status and attempted to maintain reactor depressurization via battery exchange and using other SRVs.
- The integrated Fukushima NPS Accident Response Headquarters was installed at 05:35 on March 15.

○Details of activity after "March 15 Around 06:14 Large collision noise occurred, accompanied by vibrations, Downscaling of S/C pressure readings"

- A large sound of collision and vibrations occurred around 06:14 on March 15.[2]
- Operators in the Unit 2 side of the Units 1 and 2 MCR performed regular (at this time, in 15

2 As a result of seismograph measurement records checked in later surveys, the explosion at Unit 4 was deemed to have occurred at 06:12.

min. intervals) data collection of D/W pressure and S/C pressure from the AM control panel. They reported the results for 06:00 to the Shift Supervisor. They suddenly heard sounds of impact while on standby at the control panel for the next regular data collection. When operators checked D/W pressure and S/C pressure, they discovered that the indicating value of S/C pressure was downscaling. At the same time, the Shift Supervisor heard sounds of impact and felt vibrations while standing on the Unit 2 side. These were different from ones experienced during the explosion at Unit 1. The Shift Supervisor ordered operators standing on the Unit 1 side to check Unit 2 parameters. Operators who checked the data discovered that the indicating value of the S/C pressure was downscaling. The MCR reported to the station ERC that S/C pressure was 0kPa [abs].

- The Units 1 and 2 MCR was commissioned to check data several times from the plant operation team and confirmed that D/W pressure was 730kPa [abs] and that S/C pressure was downscaling. Afterwards, they were notified by the plant operation team of the order for temporary evacuation, and they evacuated to the seismic isolated building via the cars parked near the protected area gate on the Units 1 through 4 side. The entrance to the seismic isolated building was crowded with personnel evacuating from the station to head for Fukushima Daini. They had to maneuver through this tide of people to enter the seismic isolated building.
- Around this time, the Unit 4 side ceiling of the Units 3 and 4 MCR shook when sounds of impact were heard.
- Three operators headed to the Units 3 and 4 MCR at 06:00 on March 15 to take over for the next shift. When they entered the Units 3 and 4 S/B, they felt a strong wind blow at their backs. After entering the MCR to confirm conditions, they were notified by the plant operation team of the order for temporary evacuation. Along with the three personnel already in the MCR, these six operators began evacuation to the seismic isolated building. When they exited the Units 3 and 4 S/B, the surrounding area was covered in debris. They hopped into the cars driving by and headed for the seismic isolated building. When they looked at the Unit 4 R/B while on their way, they saw that the area near the 5F was damaged. Roads near the R/B could not be traversed due to scattered debris. Operators were forced to exit their vehicles, run away from the Unit 4 R/B area, then walk the rest of the way to the seismic isolated building. While on their way to the seismic isolated building, they saw many cars going towards the main gate to evacuate from the station. When they

Unit 4 damage (on right side of photo)
(Unit 2 is on left side of photo)

finally arrived at the seismic isolated building, they reported Unit 4 conditions to the station ERC.

- Upon receiving reports that indicating value of S/C pressure was 0kPa [abs] at 06:30 on March 15, the station ERC decided to temporarily evacuate to Fukushima Daini considering the possibility of S/C damage, excluding the personnel required for station monitoring and emergency restoration activities. These necessary persons were selected by the leader of each station ERC team. Approx. 650 personnel headed to Fukushima Daini via bus or personal vehicles. Immediately after the evacuation, approx. 70 personnel stayed behind in the station ERC. Around noon of March 15, personnel gradually returned to the Fukushima Daiichi NPS to restart or continue restoration work. These included operators performing data monitoring in the MCR, the health physics team, which performed field radiation level measurement and seismic isolated building access control, and the security guidance team, which performed station access control. Around the evening of the same day, the restoration team (civil engineering team）, which performed explosion debris removal, returned to the Fukushima Daiichi NPS.
- A legally mandated order to “continue seawater injection” was given by the Minister of Economy, Trade, and Industry at 10:30 on March 15. This was shared via teleconferencing at 10:37[3].
- Parameters such as D/W pressure were collected in the MCR by operators who went there every few hours.
  - D/W pressure drop was confirmed at 11:25 on March 15. S/C pressure was still downscaling (D/W pressure: 730kPa [abs] (7:20) → 155kPa [abs] (11:25)).
- In the meantime, the health physics team continued outdoor radiation level measurement via a monitoring car. Main gate levels reached the highest post-accident at 09:00 on March 15 (11,930μSv/h).

End

[3] The order document stated that “reactor injection should be performed as soon as possible. Perform D/W venting as needed.”

Timeline of major events at Fukushima Daiichi Nuclear Power Station Unit 3 from the occurrence of the earthquake until March 15 (Tue.)

March 11, 2011 (Fri.)

14:46 **Tohoku-Chihou-Taiheiyo-Oki Earthquake occurred.** Level 3 state of emergency automatically issued.

14:47 **Reactor entered automatic scram,** main turbine manually tripped.

14:48 Emergency diesel generators automatically activated.

14:54 Reactor confirmed to be sub-critical.

15:05 Reactor core isolation cooling system (RCIC) manually activated.

15:06 Emergency Disaster Countermeasures Headquarters established at headquarters (for understanding earthquake damage status and restoring power).

15:25 RCIC automatically shut down (reactor water level high).

15:27 First tsunami wave arrived.

15:35 Second tsunami wave arrived..

15:38 Station black out (SBO)

15:42 **Situation (SBO) deemed to fall under Article 10, Section 1 of the Act on Special Measures Concerning Nuclear Emergency Preparedness (hereinafter referred to as "Nuclear Emergency Act"), and government agencies were notified.**

15:42 Level 1 state of emergency for nuclear disasters issued. Emergency Response Center (ERC) established (joint headquarters with Emergency Disaster Countermeasures Headquarters).

Around 16:00 **On-site road soundness checks began.**

Around 16:00 **Power source facility (off-site power) soundness check began.**

16:03 **RCIC manually activated.**

16:10 **Headquarters Distribution Department ordered all station to secure high/low voltage power supply cars and confirm transport routes.**

16:36 Level 2 state of emergency issued.

Around 16:50 **High/low voltage power supply cars sent from all stations to Fukushima Prefecture in turn.**

Around 18:00 **Power source facility (Electrical Power Distribution System) soundness checks began.**

Around 19:00 **Gate between Units 2 and 3 opened, securing vehicle travel routes to**

Units 1 to 4.

19:24 On-site road soundness check results reported to station ERC.

20:50 Fukushima Prefecture ordered evacuation of residents within a 2km radius of Fukushima Daiichi Nuclear Power Station (NPS).

20:56 Power source facility (off-site power, Electrical Power Distribution System) soundness check results reported to station ERC.

21:23 Prime Minister ordered evacuation of residents within a 3km radius of Fukushima Daiichi NPS, and retreat to indoor areas for residents within a 3km to 10km radius of said NPS.

21:27 Temporary lighting turned on in the main control room (MCR).

Around 22:00 Arrival of one high voltage power supply car of the first group of Tohoku Electric confirmed.

March 12, 2011 (Sat.)

00:30 Evacuation as per order from the central government for residents confirmed to be completed (evacuation for residents within a 3km radius of Futaba and Okuma Towns confirmed to be completed, re-checked at 01:45)

Around 01:20 Arrival of one TEPCO high voltage power supply car confirmed.

03:27 Diesel-driven fire pump (DDFP) failed to activate.

04:55 Site radiation level increase (near main gate: 0.069μSv/h (04:00) → 0.59μSv/h (04:23)) confirmed, and government agencies were notified.

05:44 Prime Minister ordered evacuation of residents within a 10km radius of Fukushima Daiichi NPS.

07:11 Prime Minister arrived at Fukushima Daiichi NPS.

08:04 Prime Minister departed from Fukushima Daiichi NPS.

Around 10:15 The 72 power supply cars dispatched by TEPCO and Tohoku Electric confirmed to have arrived in Fukushima (high voltage power supply cars: 12 to Fukushima Daiichi and 42 to Fukushima Daini; low voltage power supply cars: 7 to Fukushima Daiichi and 11 to Fukushima Daini).

11:13 DDFP automatically activated.

11:36 DDFP shut down.

11:36 RCIC automatically shut down.

12:06 DDFP activated, alternate S/C spray via DDFP began.

12:35 High-pressure coolant injection system (HPCI) automatically activated (reactor water level low).

16:27 Situation (abnormal site boundary radiation level increase) deemed to fall under

Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (1,015μSv/h) measured near monitoring post No. 4, and government agencies were notified.

17:30 Site superintendent ordered venting preparations to begin.

18:25 Prime Minister ordered evacuation of residents within a 20km radius of Fukushima Daiichi NPS.

20:36 Reactor water level became unclear due to reactor water level gauge power loss.

March 13, 2011 (Sun.)

02:42 HPCI shut down in order to switch DDFP to alternate reactor injection.

02:45 Attempted to open one safety relief valve (SRV) valve, but it failed to open. Later attempted to open all valves in turn, but they all failed to open.

03:05 It was reported to MCR that alternate reactor injection line assembly was complete.

03:51 Reactor water level gauge restored.

04:52 Suppression chamber (S/C) vent valve (AO valve) isolation valve opening operation was performed, but said valve was confirmed to be closed since air tank compression pressure was “0.”

05:08 Alternate S/C spray via DDFP began (halted at 07:43).

05:10 Situation (loss of reactor cooling function) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to failure of reactor injection via RCIC, and government agencies were notified at 05:58.

05:15 Site superintendent ordered completion of venting line (excluding rupture disk).

05:23 Air tank replacement began in order to open S/C vent valve (AO valve) isolation valve.

05:50 Press release on implementation of venting.

06:19 Top of the active fuel (TAF) deemed to have been reached at 04:15, and government agencies were notified.

07:35 Results of simulated venting exposure assessment notified to government agencies.

07:39 Primary Containment Vessel (PCV) spray began, and government agencies were notified at 07:56.

08:35 PCV vent valve (MO valve) opened.

08:41 Venting line assembly (excluding rupture disk) completed upon S/C vent valve (AO valve) isolation valve opening, and government agencies were notified at 08:46.

08:56 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (882μSv/h) measured near monitoring post No. 4, and government agencies were notified at 09:01.

Around 09:08 Rapid reactor depressurization via SRV performed. Government agencies were notified at 09:20 that reactor injection via fire protection system (FP) line would start later on.

09:25 Reactor freshwater injection using FP line via fire engines began (boron included).

09:36 Dry Well (D/W) pressure drop from around 09:20 due to venting operation confirmed. This and start of reactor injection via FP line were notified to government agencies.

10:30 Site superintendent ordered consideration of seawater injection.

11:17 S/C vent valve (AO valve) isolation valve confirmed closed (due to reduced actuation air tank pressure).

12:20 Freshwater injection completed.

12:30 S/C vent valve (AO valve) isolation valve opened (actuation air tank replaced).

13:12 Reactor seawater injection using FP line via fire engine began.

14:15 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (905μSv/h) measured near monitoring post No. 4, and government agencies were notified at 14:23.

14:20 Power transmission to Unit 4 P/C via high voltage power supply cars began.

14:31 Results of Reactor Building (R/B) airlock measurement (north side: over 300mSv/h, south side: 100mSv/h) reported.

14:45 R/B airlock area radiation levels rose, suggesting the possibility of hydrogen accumulated inside the R/B as was the case at Unit 1. Due to the increased risk of explosion, field evacuation began (work restarted around 17:00).

March 14, 2011 (Mon.)

01:10 Fire engines were shut down to supply seawater to the back wash valve pit since supplies of seawater provided to the reactor had grown low.

02:20 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (751μSv/h) measured near main gate, and government agencies were notified at 04:24.

02:40 Situation (abnormal site boundary radiation level increase) deemed to fall under

Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (650μSv/h) measured near monitoring post No. 2, and government agencies were notified at 05:37.

03:20 Seawater injection via fire engine restarted.

04:00 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (820μSv/h) measured near monitoring post No. 2, and government agencies were notified at 08:00.

05:20 S/C vent valve (AO valve) bypass valve opening operation began.

06:10 S/C vent valve (AO valve) bypass valve confirmed to be open.

Around 06:30 D/W pressure rose, and field evacuation began due to concerns over risk of explosion (work restarted around 07:35).

09:05 Seawater provision from unloading wharf to backwash valve pit began.

09:12 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (518.7μSv/h) measured near monitoring post No. 3, and government agencies were notified at 09:34.

11:01 Explosion occurred at R/B.

13:05 Seawater injection line (including fire engines) assembly was restarted due to damage to fire engines and hoses rendering injection line unusable.

Around 15:30 Fire engines and hoses were damaged due to the explosion, causing seawater injection to halt. Therefore, the fire engines and hoses were replaced, and a new reactor injection line from the unloading wharf was assembled. Afterwards, seawater injection was restarted.

21:35 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (760μSv/h) measured near the main gate, and government agencies were notified at 22:35.

March 15, 2011 (Tue.)

05:35 Unified Fukushima NPS Accident Response Headquarters established.

Around 06:14 Large collision noise occurred, accompanied by vibrations. Unit 4 side ceiling of MCR shook.

06:50 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (583.7μSv/h) measured near the main gate, and government agencies were notified at 07:00.

07:00 It was notified to government agencies that personnel would temporarily evacuate to Fukushima Daini, save the minimum needed for monitoring work activities.

07:55 It was confirmed that steam was drifting in the upper areas of R/B, and this was notified to government agencies.

08:11 Situation (abnormal radioactive material release due to fire/explosion) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (807μSv/h) measured near the main gate, and government agencies were notified at 08:36.

11:00 Prime Minister ordered retreat to indoor areas for residents within areas between a 20km and 30km radius from Fukushima Daiichi NPS.

16:00 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (531.6μSv/h) measured near the main gate, and government agencies were notified at 16:22.

23:05 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (4,548μSv/h) measured near the main gate, and government agencies were notified at 23:20.

End

Response status concerning Fukushima Daiichi Nuclear Power Station Unit 3 cooling water injection

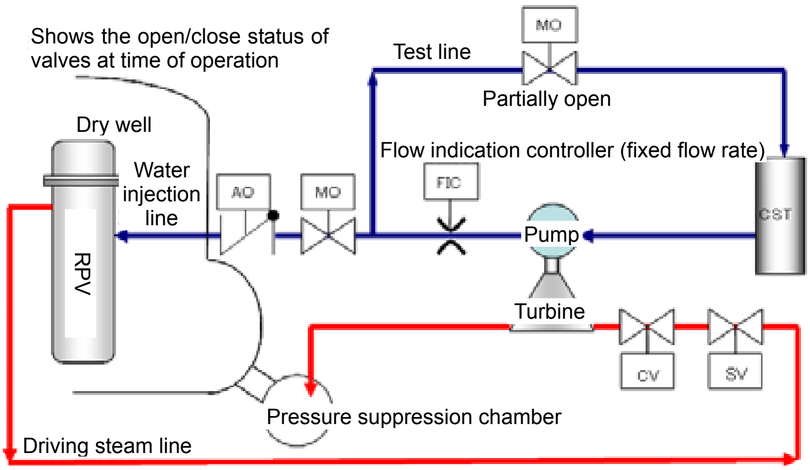
○Details of activity after "March 11 16:03 reactor core isolation cooling system manually activated"

Although the AC power source was lost, the DC power source was unaffected and thus usable. The said DC power source was used to secure reactor water levels via the reactor core isolation cooling system (RCIC) and the high-pressure coolant injection system (HPCI) used for operation control, in accordance with operating procedures.

[Securing reactor water level via RCIC]

- Operators implemented measures to avoid automatic shutdown due to high reactor water level and to conserve batteries needed for operation control. This was done to avoid battery use due to RCIC startup/shutdown and to secure stable reactor water levels.
  - ➢ One of the measures to prevent RCIC automatic shutdown due to high reactor water level was assembling a line via operation of the RCIC control panel to pass water through both the reactor injection line and test line (used for periodic function tests, loops from the water source Condensate Storage Tank (CST) back to the CST), performed while monitoring reactor water level from the Main Control Room (MCR). This set the scope of water level adjustment and secured water level.

RCIC control panel (taken at a later date)

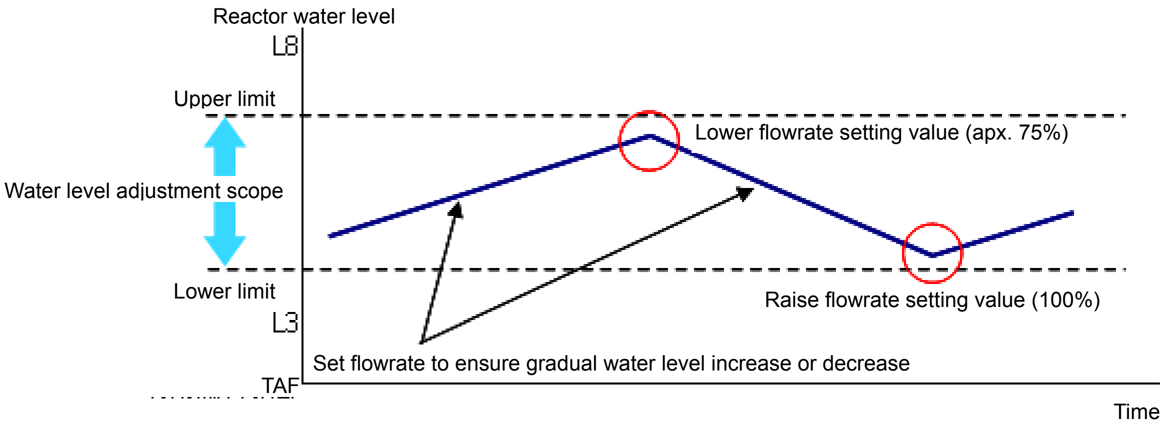


RCIC and HPCI reactor injection line overview

- Two personnel were assigned to reactor water level monitoring, while another two were assigned to RCIC operation. Under this framework, both parties reported conditions to each other while working. Preparations toward smooth HPCI startup as the next injection measure following RCIC shutdown were carried out (e.g., HPCI control panel operation switches tagged).

RCIC FIC (taken at a later date)

- In order to limit valve and Flow Indication Controller (FIC) operation as a battery conservation measure, flowrate was set via test line valve openness adjustment and FIC, to ensure gradual changes in reactor water level. The method used involved repeatedly changing flowrate setting values (within approx. 75% to 100% of standard flowrate (25.2L/s) each time the reactor water level neared the upper or lower limits of water level adjustment scope.



Reactor water level adjustment method (example)

- As a further battery conservation measure, loads were disconnected for all monitoring instruments, control panels, or computers not strictly required for monitoring or operation control. Since monitoring instruments were redundant (Subsystems A/B), one system was used at a time to reduce battery consumption. Other measures included disconnecting MCR emergency lighting / clocks, as well as fluorescent lights in other rooms.
- Load disconnection work involved first checking load via power distribution line and system schematic diagrams, then setting breakers on the power panel located in the C/B 1F cable bolt room to the "off" position. The lack of equipment

to keep in contact with the MCR meant personnel had to be set at field and MCR exits, since the cable bolt room was a controlled area and the MCR was an uncontrolled area. These personnel were used to shout load disconnection orders and the presence of abnormal conditions to each other while performing work.

[Diesel-driven fire pump (DDFP) activation and alternate suppression chamber (S/C) spray implementation]

- After the earthquake, the "shutdown state" MCR status display light for the DDFP (used for alternate injection) was on. It could not be activated using MCR operation switches when this was attempted at 03:27 on March 12.
- Since the RCIC (performing reactor injection) drive turbine exhaust steam and release SRV (controlling reactor pressure increase) exhaust steam were being released into the S/C, Dry Well (D/W) pressure showed signs of rising on March 12. Alternate S/C spray via DDFP was deliberated as a method of controlling S/C and D/W pressure increase. Operating procedures and valve location were checked using the AM manual.
- Operators were divided into two teams, which headed to the Reactor Building (R/B) and Turbine Building. Their purpose was to assemble an alternate S/C spray line from the fire protection system (FP) line via the residual heat system (RHR). The motor-operated valve (MO valve) for said line could not be operated from the MCR since there was no power source. Operators manually opened the five valves, including RHR, during the morning of March 12. They did so wearing full face masks in a totally dark building, with only flashlights for lighting.
- The SRV was operational while S/C spray valves were being manually opened in the torus room. The sound of reactor steam being released into the S/C could be heard.
- While performing DDFP field checks, operators found that the FP room FP control panel "failure" status display light was on. The FP control panel failure restoration button was pushed at 11:13 on March 12 and automatic activation was confirmed. This was also confirmed in the MCR when the DDFP "startup" status display light turned on. Since startup was confirmed, the operation switch in the MCR was used to shut it down. However, since it automatically activated yet again, operators had to head into the field once again to press the FP control panel emergency shutdown button at 11:36 to shut it down.
- The FP control panel failure restoration button was pushed at 12:06 on March 12, automatically activating the DDFP to begin alternate S/C spray.

○**<u>Details of activity after "March 12 11:36 RCIC automatically shut down"</u>**

[RCIC shutdown and restart conditions]

- While efforts to secure reactor water level were going smoothly, the MCR RCIC “shutdown” status display light turned on, and display values for the flowrate and discharge pressure gauges dropped to “0.” This confirmed that the RCIC had shut down. Shutdown notification alarms did not activate, as power had been lost.
- Two operators were sent to the R/B basement floor RCIC room for field checks. They were dispatched since the RCIC would shut down immediately after activation via the MCR RCIC control panel. They wore full face masks and long boots used for outdoor patrols. Using flashlights for light, they entered the RCIC room from the HPCI room side. Both rooms were flooded to about ankle height, although this situation was nothing to worry about. Water was dripping from the RCIC room ceiling onto the RCIC steam stop valve, but there were no abnormalities in turbines, pumps, or pipes.
- Shutdown status was confirmed in the field and no abnormalities found for steam stop valve machinery. Therefore, activation was attempted from the MCR, but the steam stop valve closed immediately after startup, causing shutdown.

[Securing reactor water level and performing reactor depressurization via HPCI]

- While RCIC shutdown status check and startup operation were underway, the HPCI automatically activated due to low reactor water level and began reactor injection again at 12:35 on March 12. Reactor depressurization via HPCI drive turbine consumption of reactor steam commenced.
- The line was assembled by operating the HPCI control panel to pass water through both the reactor injection and test lines, as had been done for the RCIC. The framework for this work had two operators monitoring reactor water level, and two operating HPCI. Setting HPCI flowrate proved difficult, since its flowrate capacity was larger than the RCIC, and thus, reactor water level increased faster. This meant reactor water level had to be secured at levels within a wide water level adjustment scope while also preventing HPCI automatic shutdown due to high reactor water level. Also, the minimum flow valve was fully closed to prevent water level increase at its destination (S/C).
- As with the RCIC, battery conservation

HPCI FIC (taken at a later date)

HPCI control panel

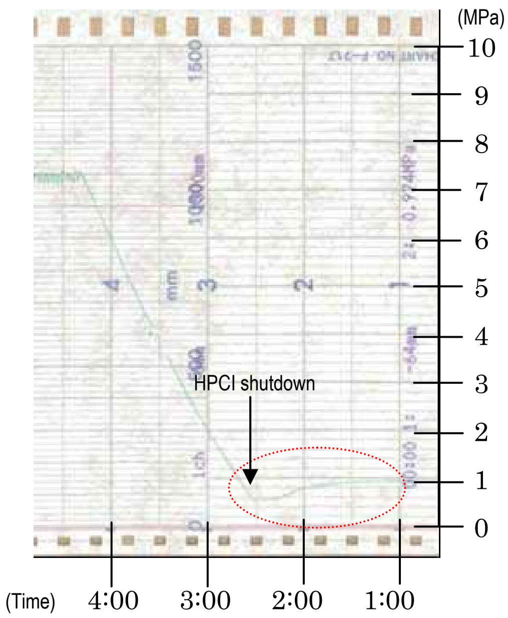
Minimum flow valve open/close circuit was fully closed to prevent S/C water level increase measures involved setting flowrate via FIC and test line valve openness adjustment to ensure gradual reactor water level changed. The method used involved repeatedly changing flowrate setting values (within approx. 75% to 100% of standard flowrate (268L/s) each time the reactor water level neared the upper or lower limits of water level adjustment scope.

- The shared understanding between the station ERC and MCR regarding reactor injection via extant equipment was that HPCI would be used after RCIC, and DDFP would be used after RCIC.
- Drive turbine intake steam pressure dropped due to reactor pressurization, reducing the speed of turbine revolutions and causing the HPCI pump discharge pressure to remain low while operating. The station ERC and MCR spread the word that injection would switch to DDFP if HPCI injection became unstable, and regularly shared HPCI operational state.
- Reactor water level gauge power source was lost at 20:36 on March 12, meaning reactor water level could no longer be monitored. Operators slightly increased HPCI flowrate setting values to ensure reactor injection, monitoring operation state via reactor pressure and HPCI discharge pressure. Also, the restoration team was commissioned to restore the reactor water level gauge.
- A 24V power source was needed to restore the reactor water level gauge. There were 2V batteries at the station on loan from the Hirono thermal power station, and the restoration team decided to use 12 of those batteries. Three members of the restoration team loaded the batteries (weighing approx. 10kg each) into a car, then headed for the Units 3 and 4 MCR.

○Details of activity after "March 13 02:42 HPCI shut down"

[HPCI shutdown conditions]

- HPCI turbine revolution speed was low, below the operation range listed in the operating procedures. HPCI discharge pressure was also low, and could have stopped at any time. Reactor water level could not be monitored, and water level remained unclear.
- Operators monitored reactor pressure and HPCI discharge pressure while keeping various considerations in mind, such as "is reactor injection being performed," "has reactor water level been secured," and "when the switch to



Reactor pressure chart
(Was stable at approx. 1MPa, but began dropping around 02:00, eventually going below 0.69MPa.)

DDFP should be made."

- Under such circumstances, around 02:00 on March 13, the reactor pressure showed signs of dropping, which had been stabilized at approx. 1MPa until this time. The plant operation team and MCR feared the possibility of reactor pressure drop causing a further slowing of HPCI turbine revolution speed, which would increase turbine vibrations and ultimately result in reactor steam release due to equipment damage.[1] Reactor pressure and HPCI discharge pressure equalized, meaning that reactor injection via HPCI was no longer being performed. Reactor pressure had dropped below levels where the HPCI would normally shut down (0.69MPa), but the HPCI did not shut down. These factors led to the decision to immediately perform alternate reactor injection via DDFP, alongside shutdown of the HPCI.
- Operators headed to the R/B in order to check the status of the DDFP (already operating before HPCI shutdown) and manually open the RHR intake valve to allow switching from alternate S/C spray to alternate reactor injection.
- The Shift Supervisor notified the plant operation team that HPCI shutdown operation was to take place. The decision to perform this operation was based on the belief that the MCR SRV status display light being on meant it was operable, as well as the time elapsed since operators had headed into the field, meaning that an alternate reactor injection line assembly had been completed.
- Operators pressed the HPCI shutdown button on the MCR HPCI control panel and set the HPCI turbine steam inlet valve operation switch to the "fully closed" position at 02:42 on March 13, and thus, shut down the HPCI. Reactor pressure at the time had dropped to 0.58MPa.

[Transition to alternate reactor injection via DDFP]

- In attempts to continue reactor depressurization, SRV 1 valve operation switch on the MCR SRV control panel was set to the "open" position at 02:45 on March 13 in order to switch from alternate reactor injection via HPCI to injection via DDFP. However, the said valve refused to open. Afterwards, all SRV valve operation switches were set to the "open" position, but they refused to open. It was reported to the station ERC that reactor pressure was rising and DDFP injection could not be performed.
- Operators who went into the field prior to HPCI shutdown to manually open the RHR intake valve had completed assembly of an alternate reactor injection line. This was reported to the MCR at 03:05 on March 13.
- Operators, assuming that the failure to open was due to SRV drive nitrogen gas not being

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[1] Damage near the HPCI turbine was believed to have caused reactor steam that drives said turbines to be released within the HPCI room.

supplied, headed into the field to supply this gas from supply lines. The supply line valve was an AO valve, making it structurally impossible to open manually.

- Under such circumstances, since reactor pressure was rising, operators deliberated activating the HPCI and RCIC to perform high pressure injection. The station ERC concurrently proceeded with power restoration via power supply cars, whose preparations had been going on since March 12. They also deliberated on reactor injection via SLC (which could perform high pressure injection), and began dispatching fire engines.

[RCIC and HPCI restoration status]

- When operators checked the MCR HPCI control panel at 03:35 on March 13 prior to starting up the HPCI, the operation control FIC display light was turned off, and thus, the HPCI could not be activated.
- Startup of the vacuum pump via the RCIC control panel was attempted as part of RCIC startup preparations at 03:37 on March 13. However, the said pump failed to activate.
- Since the MCR SRV status display light turned on at 03:38 on March 13, the SRV operation switch was set to the “open” position again. However, it failed to open.
- The HPCI aux. oil pump (still operating after HPCI shutdown) was shut down at 03:39 on March 13 to keep the DC power source going for as long as possible. At 04:06, the HPCI condensate pump was also shut down.
- Reactor pressure rose to 4.1MPa at 03:44 on March 13. It reached approx. 7MPa at around 04:30. It would then transition between approx. 7.0 to 7.3MPa from then onward.
- The restoration team had been performing reactor water level gauge restoration work since the early hours of March 13. Twelve 2V batteries were connected in a series to create a 24V power source for the reactor water level gauge. The reactor water level gauge was restored at 03:51. Reactor water level at that time was near TAF.
- The Shift Supervisor discussed RCIC status with the plant operation team. It was decided that the RCIC would be started up without the vacuum pump to secure reactor injection as soon as possible. Two operators who had performed field response on March 12 during RCIC shutdown headed to the R/B basement floors.
- When these two operators entered the HPCI room, it was slightly hotter inside than on March 12. After confirming HPCI shutdown status was normal, they moved to the RCIC room. They checked the locking status of RCIC steam stop valve machinery structure, adjusted it, then checked the status prior to startup.


RCIC (Unit 5 side, with light)


HPCI (Unit 5 side, with light)

There were several pipes and support beams within the RCIC and HPCI rooms. The only source of light was flashlights, and there was water on the floors while operators moved and worked.

- The FIC was set to a low flowrate from the RCIC control panel to ensure steam stop valve machinery structure locking status would be unaffected by vibrations in the event of RCIC activation. Activation was performed via the RCIC control panel at 05:08 on March 13, but the steam stop valve machinery structure became dislodged, closing the said valve and leading to shutdown. Operators decided to return to the MCR. APD values were not high when checked.
- The situation (reactor cooling function loss) was deemed by the station ERC to fall under Article 15, Section 1 of the Nuclear Emergency Act due to an inability to activate the RCIC at 05:10 on March 13, and this was reported to government agencies at 05:58.

[Carrying out alternate S/C spray and D/W spray via DDFP]

- Since assembly of the venting line was not yet complete, the station ERC decided to restrict pressure increase via alternate S/C spray when D/W and S/C pressure rose.
- Operators manually closed the reactor injection line RHR intake valve at 05:08 on March 13. They then went to the torus room to manually open the S/C spray valve to begin S/C spray.
- The torus room where the S/C spray valve was installed was hot and muggy. Lighting power had been lost, meaning the room was totally dark and the only source of light was flashlights. Since the SRV was active, large


Torus room entrance (Unit 5 side, with light)

Operators headed toward the S/C spray valve to manually open it. The room was hot, muggy, and pitch black, lit only by flashlights.

noises caused by S/C steam release came intermittently, causing large vibrations that terrified operators. The mood was also tense due to several big aftershocks that had been striking since the earthquake on March 11.

- Operators manually operated valves, switching from the S/C spray line to the D/W spray line at 07:39 on March 13, and began D/W spray. The S/C spray valve was manually closed at 07:43.
- The torus room had become even hotter by the time the S/C spray valve was closed. Soles of the rubber boots being worn by operators melted when they set foot on the upper parts of the S/C. The S/C spray valve operation handle was also hot, and could not be held for long periods of time.

S/C spray valve (Unit 5 side, with light)

The orange parts are the S/C. The S/C spray valve was located on the upper part of the torus, meaning its handle could not be moved unless personnel climbed on top of it.

- The D/W and S/C pressure increase was halted due to the D/W spray, and the pressure plateaued. The station ERC decided to stop the D/W spray and expedite PCV venting line assembly toward early implementation of PCV venting.
- Operators manually opened the RHR intake valve, manually closed the D/W spray valve, and switched to the reactor alternate injection line between 08:40 and 09:10 on March 13.

[Preparing for alternate reactor injection via fire engine]

- Reactor injection equipment (e.g., SLC) power source restoration SLC was advanced alongside fire engine distribution.
- The fire engine from Kashiwazaki-Kariwa, on standby at Fukushima Daini, departed around 05:30 on March 13. It arrived at Fukushima Daiichi around 06:30. When the Units 5 and 6 side fire engines were checked around 06:00, they were confirmed to be usable. They were then collected for use in reactor injection at Unit 3.
- The fire brigade recommended to the site superintendent that seawater in the Unit 3 backwash valve pit be used as a source of water for the fire engine injection line (seawater injection line) at 05:21 on March 13. This was the same setup used at Unit 1. After gaining site superintendent approval, they began assembling the line. All that remained was to place fire engine hoses in the water source (Unit 3 backwash valve pit), and the said line would have been complete. However, the TEPCO government liaison notified the site superintendent around 06:50 on March 13 that freshwater injection should be given top

consideration. Therefore, the switch was made to a freshwater injection line using the FP tank as a source of water.

[Reactor depressurization via SRV, alternate reactor injection via fire engine and DDFP]

- It was discovered that power restoration via power supply cars for reactor injection via Unit 3 SLC would take some time. Thus, the only choices for reactor injection remaining were via DDFP or fire engine.
- Reactor depressurization via SRV would be necessary for reactor injection via DDFP or fire engine. It was believed ten 12V batteries would be needed as a DC power source (125V) to operate the SRV. However, all appropriate batteries were already being used for Units 1 and 2 instrument restoration.
- The station ERC called for employees within the seismic isolated building to donate their car batteries around 07:00 on March 13. The required number of personnel was gathered, and they removed the batteries from their cars, placing them in front of the seismic isolated building. Five members of the restoration team transported these batteries to the Unit 3 MCR in their personal vehicles.

SRV control panel (taken at a later date)

- While connecting 12V batteries into ten unit parallels, two operators from the restoration team discovered that reactor pressure was dropping around 09:08 on March 13. Of the SRV control panel status display lights, the red lamp showing “open (active)” status for one of them flickered on and off, while the green lamp showing “closed” status for the same one was also on. Immediately afterwards, both the red and green lamps for another SRV both turned on. Thus, there were two SRVs stuck between the “open” and “closed” status.
- Rapid reactor depressurization began. Due to reactor depressurization, injection via DDFP was begun. Injection via fire engine also began, at 09:25. Requests for additional supplies of freshwater were performed alongside the taking of water from the on-site training center mock fuel pool. This water was supplied to the FP tank while continuing injection.
- The restoration team completed connection of ten batteries to a parallel, which were then connected to the MCR SRV control panel. Operators opened the SRV via operation switch at 09:50 on March 13 to maintain depressurization. Afterwards, reactor pressure rose around 12:00. When the SRV control panel was checked, it was found that the status display light had turned off. After investigating the cause, it was discovered that one of the battery lines had become disconnected. The line was reconnected, the SRV opened, and reactor depressurization began again. SRV status was determined from then on via reactor

pressure increase status, and reactor depressurization maintained via battery replacement and use of other SRVs.

[Deliberating explosion prevention measures]

- After the Unit 1 R/B explosion, the head office ERC nuclear power restoration team suspected from an early stage that the cause of the explosion was hydrogen. They began deliberations on methods to remove the hydrogen trapped within the R/B.
- The site superintendent stated at 09:43 on March 13 that, while it could not be conclusively proved that hydrogen was the cause of the explosion, it was important that a similar explosion would not occur again. Deliberations on prevention measures were carried out with the head office ERC.

○Details of activity after "March 13 10:30 Site superintendent ordered consideration of seawater injection"

[Transition to seawater injection]

- Freshwater injection was being performed while supplying the FP tank. Since supplies of freshwater in FP tanks nearby grew low at 12:20 on March 13, the fire brigade began changing the line to inject seawater from the Unit 3 backwash valve pit. Thanks to advance preparations to allow this to take place in a short amount of time, line assembly was completed at 13:12 and seawater injection began.
- The DDFP continued operating, even while reactor seawater injection via fire engine was halted to change water sources.

Unit 3 backwash valve pit

[Pre-explosion evacuation and deliberation of explosion prevention measures]

- Since the radiation levels on the other side of the R/B airlock were around 300mSv/h, the station ERC believed there was a possibility that hydrogen could be trapped within the R/B and cause an explosion similar to the one at Unit 1 and decided to temporarily evacuate workers in MCR and in the field at 14:45 on March 13.
- After evacuating, the order for evacuation was removed for venting line soundness investigation and seawater injection line manual repair work around 17:00 on March 13. Work on these two tasks then began.

- The chief cabinet secretary held a press conference about conditions at Unit 3 in the afternoon of March 13, in the official residence, and stated that there existed a possibility that a hydrogen explosion could occur.
- Later, various methods to remove hydrogen within the R/B were suggested, such as "opening a blow out panel," "making holes in the R/B roof," and "making holes in the R/B wall via water jet (hereinafter referred to as "water jet method")." However, methods other than the "water jet method" did not come to fruition due to several factors. These included the possibility of sparks created during boring causing an explosion, as well as high field radiation levels.
- Deliberations were carried out focusing on the "water jet method," and the devices were procured.

[Halting/restarting of seawater injection due to backwash valve pit water level drop]

- The station ERC continued making requests for fire engine support to the head office ERC. However, various factors (site radiation levels, site contamination, poor condition of station roads) kept fire engines from heading directly to the station. They were sent instead to the off-site center and J village, where they were helmed by employees and contractors, who drove them to the station.
- Water was taken from other sources to replenish the Unit 3 backwash valve pit.
  - ➢ Sprinkler wagons and vacuum trucks, which were on site for use in civil engineering, were used to take water from reservoirs and send it to the backwash valve pit. This process was repeated several times.
  - ➢ Turbine Building truck bay shutters were opened and fire engines let in to use the seawater trapped in the basement floors of the Unit 4 Turbine Building. However, water could not be taken since water levels were too low.
  - ➢ Attempts to take water from the Unit 4 seawater intake failed since roads to the intake had sunken and could not be travelled. The inspection manhole was opened to try and take water from the seawater release route, but the distance from the ocean surface meant fire engines could not be used to suck up water.
- Fire engines were shut down at 01:10 on March 14 due to low supplies of seawater within the Unit 3 backwash valve pit. This was done so the said pit could be supplied with seawater, as well as to prevent fire engine pumps from burning up. Seawater used for injection at Unit 3 was provided by adjusting intake location (e.g., placing fire engines near the Unit 3 backwash valve pit and setting hose suction spots deeper), and seawater injection was restarted at 03:20.

[Pre-explosion evacuation, providing seawater to backwash valve pit]

- Four fire engines from TEPCO thermal power stations arrived at 05:03 on March 14. Preparations then took place for sending seawater directly from the ocean to the Unit 3 backwash valve pit.
- D/W pressure was still rising at 05:50 on March 14 after seawater injection was halted, and failed to stop despite an increase of the reactor seawater injection amount after the said injection began again.
- The S/C vent valve (AO valve) bypass valve was opened at 06:10 on March 14.
- D/W pressure rose to 495kPa[abs] around 06:30 on March 14. The site superintendent ordered workers to evacuate to ensure their safety due to concerns that an explosion could occur.
- Since D/W pressure stabilized at 500kPa[abs] after rising to 520kPa[abs] at 07:00, the workers who had evacuated from the field deliberated with the station ERC on future actions around 07:20 on March 14. Since water had to be supplied to the Unit 3 backwash valve pit for reactor injection, workers headed to the field by bus at 07:35 to provide seawater from the unloading wharf to the Unit 3 backwash valve pit. The fire brigade placed new fire engines at the unloading wharf and assembled a line for seawater intake, while the security team measured radiation levels. Since radiation levels for debris reached a max. of 800mSv/h, personnel were ordered to stay away from said debris.
- The Self Defense Force (hereinafter referred to as the "SDF") confirmed the possibility that sprinkler trucks could carry freshwater at 07:43 on March 14.
- Addition of boron to the Unit 3 backwash valve pit was completed at 08:52 on March 14.
- Fire engines to be used to transport water from the unloading wharf to the Unit 3 backwash valve pit were started up at 09:05 on March 14. They then continued transporting water thereafter.
- Seven 5t water supply trucks provided by the SDF arrived at the station at 10:26 on March 14. Two of those trucks headed to the Unit 3 backwash valve pit.

○Details of activity after "March 14 11:01 Explosion occurred at Reactor Building"

[Conditions at time of explosion]

- The fire brigade had been monitoring Unit 3 backwash valve pit water level and fire engine flowrate/pressure during injection. They directed SDF water supply trucks, which came to provide the Unit 3 backwash valve pit with water, to said pit.

Outside view of Unit 3 after explosion
(taken on March 21, 2011)

After directing several trucks, the sound of an explosion was heard, and the entire area was blanketed in thick white smoke. Debris began falling noisily thereafter, and the fire brigade took cover under some nearby piping. Although cover was not sufficient, this incident thankfully ended without injuries.

- After the smoke cleared, two injured employees were found walking near the Unit 3 S/B. Along with other workers in the field, they began evacuating via debris-strewn roads between Units 2/3.
- It was while workers had passed through the gate between Units 2/3 during evacuation that SDF trucks arrived. Evacuees, both injured and uninjured, rode upon the truckbeds to return to the seismic isolated building.

[Post-explosion response status]

- An explosion occurred at Unit 3 at 11:01 on March 14, which produced white smoke. Building status was later checked via TV footage.
- The site superintendent ordered evacuation and confirmation of personnel safety. They also ordered the security team to perform radiation level measurement and reporting. Since a tsunami alert was in effect, they ordered evacuation to take place as soon as possible.
- Workers in the MCR who were not operators halted their work to evacuate to the seismic isolated building.
- Unit 3 parameters were reported at 11:15 on March 14. Reactor pressure was 0.195MPa at Subsystem A and 0.203MPa at Subsystem B. D/W pressure was 380kPa[abs], and S/C pressure was 390kPa[abs]. The site superintendent deemed both the reactor and PCV to be sound since their pressures could be measured, and the measured values gave weight to this decision.
- Results of personnel safety confirmation were reported at 11:30 on March 14. Initially, around 40 personnel were reported missing. Since there were multiple injured personnel as well, a request for ambulances was made to the head office ERC (number of injured: 4 employees, 3 contractors, 4 SDF).
- The safety of operators within each MCR was confirmed at 11:40 on March 14. A total of 7 personnel were reported missing (6 SDF and 1 contractor employee). The SDF later withdrew from the area.
- It was reported that the Unit 2 reactor water level began dropping and reactor pressure began rising around 12:50 on March 14.
- The site superintendent issued an order for Unit 2 response at 13:05 on March 14. This took place while the effects of the second explosion (following the one at Unit 1) were still being felt. They stated that the "Unit 2 reactor water level drop confirmed. Will arrive at TAF

around 16:00 if this continues. Reactor injection line assembly and water source (Unit 3 backwash valve pit) restoration to be performed by 14:30. Prevent further explosions. Equipment may have been damaged by Unit 3 explosion. Do not assume they are usable."

- It was reported to the station ERC at 14:04 on March 14 that emergency exposure dosage limit would be raised to 250mSv. This decision came after adjustment between the head office and NISA.
- Workers evacuating from the field came to the seismic isolated building, and many injured were brought there. Although the security team measured contamination of injured, the situation did not allow precise measurement (both the injured and the seismic isolation building were heavily contaminated), and instrument readings were off the charts.

[Restarting reactor injection]

- After site superintendent orders, personnel headed into the field at 13:05 on March 14. There, they began field status check amidst high radiation levels due to scattered debris. The injection line was unusable due to damage sustained by fire engines/hoses near the Unit 3 backwash valve pit. Explosion debris was also scattered at the water source (Unit 3 backwash valve pit).

Injection via fire engines at unloading wharf

- Since the fire engines providing the Unit 3 backwash valve pit with seawater from the unloading wharf was fully functional and thus usable, it was decided these fire engines would be used to transport seawater from the unloading wharf to reactors at both Units 2 and 3. Alternate reactor injection line assembly (e.g. replacing damaged hoses) was carried out.
- Fire engines were started up around 15:30 on March 14 and seawater injection began again.

End

Response status concerning
Fukushima Daiichi Nuclear Power Station Unit 3
PCV venting operation

<u>○Details of activity after "March 12 17:30 Site superintendent ordered venting preparations to begin"</u>

[Preparations toward venting]

- Venting procedure deliberation began in the main control room (MCR) at just past 21:00 on March 12. Order and location of vents to be operated were listed on the whiteboard.
- The generation team deliberated venting procedures with the restoration team after Unit 1 venting operation procedures were compiled. This was done while looking at Unit 1 venting operation procedures and Unit 3 Accident Management (AM) operation procedures. The completed procedures were reported to the MCR.
- Reactor water level became unclear due to instrument power loss at 20:36 on March 12. The restoration team carried out instrument restoration work, such as carrying batteries into the MCR, preparing diagrams, confirming welding areas, and power source connection. They did so while wearing equipment such as full face masks and rubber gloves, in an MCR lit only by temporary lighting. This began alongside S/C vent valve (AO valve) isolation valve opening work.
- The reactor water level gauge was restored at 03:51 on March 13. Top of the active fuel (TAF) was possible then.
- The small generator being used to provide temporary lighting for the MCR was used to forcefully excite the solenoid valve at 04:52 on March 13, in order to open the S/C vent valve (AO valve) isolation valve. When operators went to the reactor building (R/B) basement floor torus room to check S/C vent valve (AO valve) isolation valve status, the "closed" status was displayed and the S/C vent valve (AO valve) isolation valve drive air tank compression pressure was "0." The torus room at this time was hot and muggy, as well as totally dark due to loss of lighting power. Operators only had flashlights to guide them. Since the SRV was operating, there were large vibrations and loud noises due to steam being released into the S/C.

[Venting line completion work]

- The Site superintendent ordered venting line completion (excluding rupture disk) work and press preparations to begin at 05:15 on March 13.
- The restoration team began restoration work at 05:23 on March 13, since S/C vent valve (AO valve) isolation valve drive air tank compression pressure was "0." One of the three

D/W oxygen density gauge correction tanks on the R/B 1F was removed and exchanged with the tank in the R/B 1F south side AO valve drive air tank rack. Tank connector leakage check was conducted, and it was confirmed that the tank was sound (including tank pressure).

- A press release regarding venting was issued at 05:50 on March 13.
- After the restoration team exchanged tanks, operators headed to the R/B basement floor torus room to check the open/close status of the S/C vent valve (AO valve) isolation valve. Temperatures in the torus room had risen even higher by this time. When operators set foot into the S/C upper areas to check S/C vent valve (AO valve) isolation valve open/close status, the long boots they were wearing melted. Thus, were they forced to turn back toward the MCR around 08:00 on March 13.
- The vent valve (MO valve) was manually opened to 15% at 08:35 on March 13. Although operation procedures stipulate 25% openness, it was set slightly lower (15%) to keep PCV pressure from falling too low.

Torus room conditions (Unit 5, with light)

The orange parts are the S/C. The S/C vent valve is in the upper parts of the torus room (pictured to the right, circled in red), and cannot be checked without climbing onto upper parts of the S/C. In total darkness and with only flashlights for light, operators stepped onto the upper part of the S/C. Their boots melted the moment they set foot onto it.

S/C vent valve check (example)

○Details of activity after "March 13 08:41 Venting line assembly (excluding rupture disk) completed upon S/C vent valve (AO valve) isolation valve opening"

[Maintaining venting line]

- It was reported to the station ERC at 08:41 on March 13 that venting line assembly was complete, and all that was left was to wait for the rupture disk to rupture.
- SRV was opened and rapid reactor depressurization started around 09:08 on March 13. D/W pressure rose to 637kPa[abs] (09:10), but was confirmed to have been lowered to

540kPa[abs] (09:24). The station ERC decided around 09:20 that venting had occurred.

- A temporary increase in D/W pressure was seen at 09:28 on March 13. The restoration team was in the MCR at the time. They found leaks in the connectors of the S/C vent valve (AO valve) isolation valve drive air tanks during checks of said tanks (located in the R/B 1F south side AO valve drive air tank rack), and performed repairs. Since air was left in the tanks, they were left alone. The second of the three D/W air density gauge correction tanks were removed and placed nearby, for use as the next replacement tank.
- Since dosimeter values were rising and the R/B 1F was filled with what appeared to be a thick white fog, operators evacuated from the field. After evacuating, operators and contractor workers searched for connectors in the contractor warehouse, since there was the possibility that the connectors of the replaced tanks did not fit properly.
- The restoration team began the opening operation for the S/C vent valve (AO valve) isolation valve at 11:17 on March 13, since tank pressure escape caused the said valve to close. Since both the temperature and humidity in the R/B 1F could have been very high, it was decided that tank replacement work would be performed in a two-team framework while wearing personal air supplies (wrench time: 15 min.).
- Team 1 finished exchanging tanks, using the replacement (second D/W air density gauge correction tank) placed near the R/B 1F south side AO valve drive air tank rack. Team 2 performed tank leakage and pressure checks, confirming that the S/C vent valve (AO valve) isolation valve had opened at 12:30 on March 13. D/W pressure began dropping afterwards.[1]
- At this time, the restoration team tried to lock the S/C vent valve (AO valve) isolation valve in the open position, but did not succeed.

[Field dose increase]

- Measurement results for the R/B airlock north side (over 300mSv/h, inside filled with white fog) and south side (100mSv/h) were reported at 14:31 on March 13. Radiation levels on the MCR Unit 3 side were 12mSv/h at 15:28, and operators who could be moved left for the Unit 4 side to continue monitoring the station. Since there were few operations to be performed during the afternoon in the MCRs for Units 1 and 2 and Units 3 and 4, all operators, save the minimum required for monitoring, were evacuated to the seismic isolated building. Monitoring was performed in shifts from that point onward.
- Since it was confirmed that D/W pressure had begun rising again at 15:05 on March 13,[2] it was decided that a temporary compressor would be installed in addition to the D/W air

[1] 480kPa[abs] (12:40) → 300kPa[abs] (13:00)
[2] 230kPa[abs] (14:30) → 260kPa[abs] (15:00)

density gauge correction tank. The restoration team procured the temporary compressor from contractors, and headed into the field at 17:52 to install the temporary compressor.

- Field radiation levels were high. The restoration team loaded the temporary compressor into a crane truck, then drove it near the turbine building 1F Instrument Air-System(IA) air tank. It was connected to the IA line and activated around 19:00 on March 13. They continued refueling the compressor every few hours in a highly radioactive field, thus maintaining temporary compressor operation. The temporary compressor had low capacity, and it took time to pressurize the entire IA line, meaning that signs of D/W pressure drop could not be seen for some time.
- The S/C vent valve (AO valve) isolation valve was deemed to have opened due to D/W pressure drop[3] at 21:10 on March 13.
- Since malfunctions were found in the S/C vent valve (AO valve) isolation valve exciter circuit (powered by the MCR temporary lighting small generator) at 03:40 on March 14, the solenoid valve was re-excited from the MCR.
- A new temporary compressor was received from Fukushima Daini NPS in the early morning hours of March 14, and the currently installed temporary compressor was replaced.

[Additional venting line]

- D/W pressure showed signs of rising[4] after seawater injection was halted at 01:10 on March 14, and refused to stop after seawater injection restarted at 03:20, no matter how much reactor injection amount was increased. Therefore, it was decided that the S/C vent valve (AO valve) bypass valve would be opened, and exciting of its solenoid valve for this purpose began at 05:20. Opening was completed at 06:10.
- An explosion occurred at the Unit 3 R/B at 11:01 on March 14.
- Due to a malfunction of the small generator being used to excite the solenoid valves of the S/C vent valve (AO valve) isolation valve and bypass valve at 16:00 on March 15, the said valves closed. The small generator was replaced at 16:05 to excite the S/C vent valve (AO valve) isolation valve solenoid valve and perform the opening operation.
- Keeping these valves open proved difficult from then on, due to problems with keeping the S/C vent valve (AO valve) isolation valve and bypass valve drive air pressure/air supply line solenoid valves excited. Therefore, the opening operation was performed several times.

(S/C vent valve (AO valve) isolation valve)

- ➢ Confirmed closed at 21:00 on March 17 / Opened around 21:30 on March 17
- ➢ Confirmed closed at 05:30 on March 18 / Opened around 05:30 on March 18

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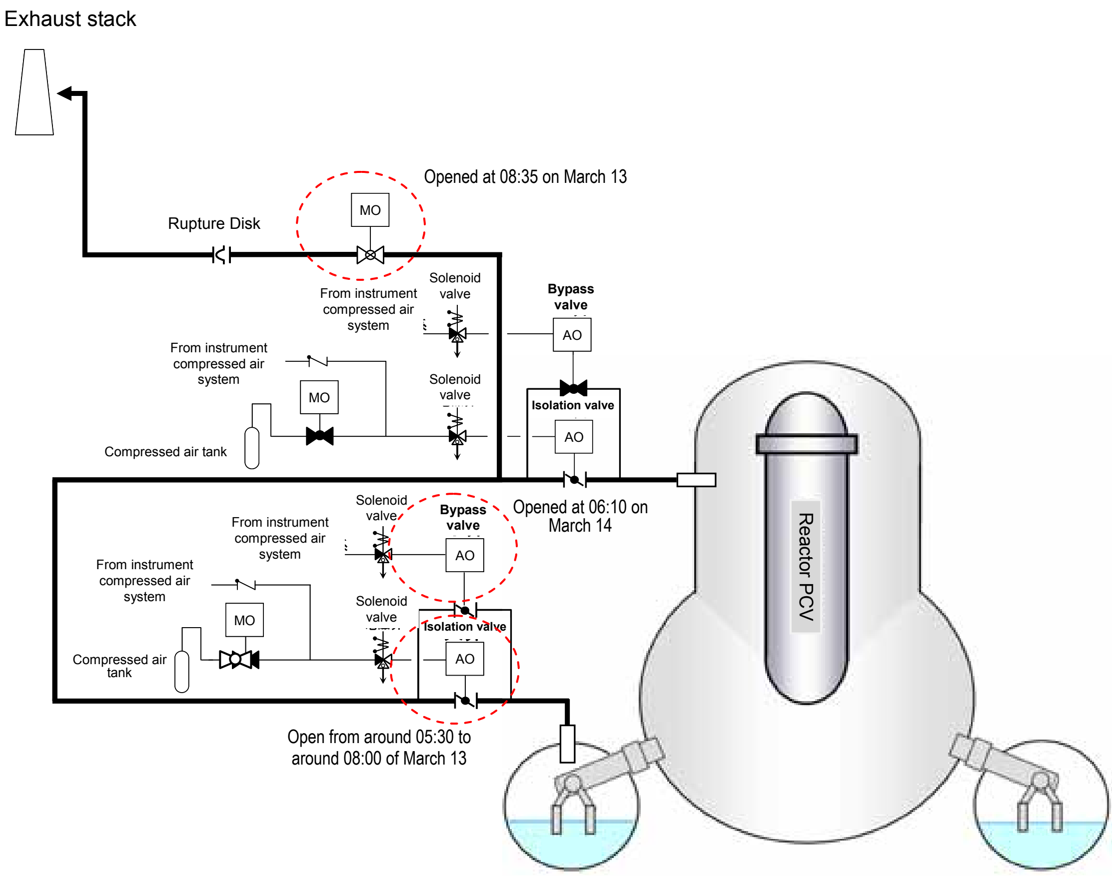
[3] 425kPa[abs] (20:30) → 410kPa[abs] (20:45) → 395kPa[abs] (21:00)
[4] 240kPa[abs] (01:00) → 255kPa[abs] (01:30) → 265kPa[abs] (02:00) → 315kPa[abs] (03:00)

- Confirmed closed at 11:30 on March 19 / Opened around 11:25 on March 20
- Confirmed closed around 18:30 on April 8

(S/C vent valve (AO valve) bypass valve)

- Opened at 01:55 on March 16
- Confirmed closed around 18:30 on April 8



Valves operated for vent line configuration

End

Timeline of major events at Fukushima Daiichi Nuclear Power Station Unit 4 from the occurrence of the earthquake until March 15 (Tue.)

[Reference: Unit 4 status at the time of earthquake occurrence]

・ Unit 4 was shut down for outage from November 30, 2010. All fuel had been removed from the reactor and placed in the spent fuel pool (SFP) due to shroud replacement engineering work.

March 11, 2011 (Fri.)

14:46 **Tohoku-Chihou-Taiheiyo-Oki Earthquake occurred.** Level 3 state of emergency automatically issued.

15:06 Emergency Disaster Countermeasures Headquarters established at headquarters (for understanding earthquake damage status and restoring power).

15:27 First tsunami wave arrived.

15:35 Second tsunami wave arrived.

15:38 Station black out (SBO) at Unit 4.

15:42 Situation (SBO) at Unit 1*, Unit 2*, Unit 3*, Unit 4* and Unit 5* deemed to fall under Article 10, Section 1 of the Act on Special Measures Concerning Nuclear Emergency Preparedness (hereinafter referred to as "Nuclear Emergency Act"), and government agencies were notified.

*Revised to Unit 1, Unit 2 and Unit 3 only on April 24, 2011

15:42 Level 1 state of emergency for nuclear disasters issued. Emergency Response Center (ERC) established (joint headquarters with Emergency Disaster Countermeasures Headquarters).

Around 16:00 On-site road soundness checks began.

Around 16:00 Power source facility (off-site power) soundness check began.

16:10 Headquarters Distribution Department ordered all stations to secure high/low voltage power supply cars and confirm transport routes.

16:36 Level 2 state of emergency issued.

Around 16:50 High/low voltage power supply cars sent from all stations to Fukushima Prefecture in turn.

Around 18:00 Power source facility (Electrical Power Distribution System) soundness checks began.

Around 19:00 Gate between Units 2 and 3 opened, securing vehicle travel routes to Units 1 to 4.

19:24 On-site road soundness check results reported to station ERC.

20:50 Fukushima Prefecture ordered evacuation of residents within a 2km radius of Fukushima Daiichi Nuclear Power Station (NPS).

21:23 Prime Minister ordered evacuation of residents within a 3km radius of Fukushima Daiichi NPS, and retreat to indoor areas for residents within a 3km to 10km radius of said NPS.

21:27 Temporary lighting turned on in the Main Control Room (MCR).

Around 22:00 Arrival of one high voltage power supply car of the first group of Tohoku Electric confirmed.

March 12, 2011 (Sat.)

00:30 Evacuation as per order from the central government for residents confirmed to be completed (evacuation for residents within a 3km radius of Futaba and Okuma Towns confirmed to be completed, re-checked at 01:45)

Around 01:20 Arrival of one TEPCO high voltage power supply car confirmed.

04:55 Site radiation level increase confirmed, and government agencies were notified.

05:44 Prime Minister ordered evacuation of residents within a 10km radius of Fukushima Daiichi NPS.

07:11 Prime Minister arrived at Fukushima Daiichi NPS.

08:04 Prime Minister departed from Fukushima Daiichi NPS.

Around 10:15 The 72 power supply cars dispatched by TEPCO and Tohoku Electric confirmed to have arrived in Fukushima (high voltage power supply cars: 12 to Fukushima Daiichi and 42 to Fukushima Daini; low voltage power supply cars: 7 to Fukushima Daiichi and 11 to Fukushima Daini).

16:27 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (1,015μSv/h) measured near monitoring post No. 4, and government agencies were notified.

18:25 Prime Minister ordered evacuation of residents within a 20km radius of Fukushima Daiichi NPS.

March 13, 2011 (Sun.)

08:56 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (882μSv/h) measured near monitoring post No. 4, and government agencies were notified at 09:01.

14:15 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (905μSv/h) measured near monitoring post No. 4, and government agencies were notified at 14:23.

14:20 Power transmission to Unit 4 P/C via high voltage power supply cars began.

March 14, 2011 (Mon.)

02:20 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (751μSv/h) measured near main gate, and government agencies were notified at 04:24.

02:40 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (650μSv/h) measured near monitoring post No. 2, and government agencies were notified at 05:37.

04:00 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (820μSv/h) measured near monitoring post No. 2, and government agencies were notified at 08:00.

04:08 Unit 4 SFP temperature confirmed to be 84ºC.

09:12 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (518.7μSv/h) measured at monitoring post, and government agencies were notified at 09:34.

Around 10:30 Personnel headed to check SFP status but were unable to enter the reactor building (R/B) due to high radiation levels.

21:35 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (760μSv/h) measured near the main gate, and government agencies were notified at 22:35.

March 15, 2011 (Tue.)

05:35 Unified Fukushima NPS Accident Response Headquarters established.

Around 06:14 Large collision noise occurred, accompanied by vibrations. Unit 4 side ceiling of MCR shook.

06:50 Situation (abnormal site boundary radiation level increase) deemed to fall under Article

15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (583.7μSv/h) measured near the main gate, and government agencies were notified at 07:00.

06:55 Unit 4 R/B 5F ceiling area confirmed to be damaged.

07:55 Unit 4 R/B 5F ceiling area damage notified to governmental agencies.

08:11 Situation (abnormal radioactive material release due to fire/explosion) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to Unit 4 R/B damage and radiation levels exceeding 500μSv/h (807μSv/h) measured near the main gate, and government agencies were notified at 08:36.

09:38 Fire confirmed in the northwest corner of Unit 4 R/B 3F, and government agencies were notifed at 09:56.

10:30 Legally mandated order issued by Minister of Economy Trade and Industry (extinguish SFP fire and prevent criticality recurrence). Another order was issued later (time unclear) to perform SFP injection as soon as possible.

11:00 Prime Minister ordered retreat to indoor areas for residents within areas between a 20km and 30km radius from Fukushima Daiichi NPS.

Around 11:00 TEPCO employees sent for field check of the fire at Unit 4 R/B confirmed it had burned out on its own, and government agencies were notified of this at 11:45.

16:00 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (531.6μSv/h) measured near the main gate, and government agencies were notified at 16:22.

23:05 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (4,548μSv/h) measured near the main gate, and government agencies were notified at 23:20.

End

Timeline of major events at Fukushima Daiichi Nuclear Power Station Unit 5 from the occurrence of the earthquake until reactor cold shutdown

[Reference: Unit 5 status at the time of earthquake occurrence]

・ Unit 5 was shut down for outage from January 3, 2011. RPV pressure resistance leakage tests were being conducted with fuel loaded on the reactor.

(Reactor pressure: approx. 7MPa, reactor water temperature: approx. 90ºC, spent fuel pool (SFP) water temperature: approx. 25ºC)

March 11, 2011 (Fri.)

14:46 **Tohoku-Chihou-Taiheiyo-Oki Earthquake occurred.** Level 3 state of emergency automatically issued.

14:47 Emergency Diesel Generators (DG) automatically activated.

15:06 Emergency Disaster Countermeasures Headquarters established at headquarters (for understanding earthquake damage status and restoring power)

15:27 First tsunami wave arrived.

15:35 Second tsunami wave arrived.

15:40 Station black out (SBO)

15:42 Situation (SBO) at Unit 1*, Unit 2*, Unit 3*, Unit 4* and Unit 5* deemed to fall under Article 10, Section 1 of the Act on Special Measures Concerning Nuclear Emergency Preparedness (hereinafter referred to as "Nuclear Emergency Act"), government agencies were notified.

*Revised to Unit 1, Unit 2 and Unit 3 only on April 24, 2011

15:42 Level 1 state of emergency for nuclear disasters issued. Emergency Response Center (ERC) established (joint headquarters with Emergency Disaster Countermeasures Headquarters).

Around 16:00 On-site road soundness checks began.

16:10 Headquarters Distribution Department ordered all stations to secure high/low voltage power supply cars and confirm transport routes.

16:36 Level 2 state of emergency issued.

Around 16:50 High/low voltage power supply cars sent from all stations to Fukushima Prefecture in turn.

19:24 On-site road soundness check results reported to station ERC.

20:50 Fukushima Prefecture ordered evacuation of residents within a 2km radius of Fukushima Daiichi Nuclear Power Station (NPS).

21:23 Prime Minister ordered evacuation of residents within a 3km radius of Fukushima Daiichi NPS, and retreat to indoor areas for residents within a 3km to 10km radius of said NPS.

Around 22:00 Arrival of one high voltage power supply car from the first group of Tohoku Electric confirmed.

Around 23:30 Personnel headed towards the field at Unit 5 and Unit 6 to inspect Electrical Power Distribution System.

March 12, 2011 (Sat.)

00:30 Evacuation as per order from the central government for residents confirmed to be completed (evacuation for residents within a 3km radius of Futaba and Okuma Towns confirmed to be completed, re-checked at 01:45)

Around 01:20 Arrival of one TEPCO high voltage power supply car confirmed.

Around 01:40 Safety relief valve (SRV) automatically opened (maintained at approx. 8MPa from then on by repeatedly opening and closing the valve).

04:55 Site radiation level increase confirmed, and government agencies were notified.

05:44 Prime Minister ordered evacuation of residents within a 10km radius of Fukushima Daiichi NPS.

06:06 Reactor Pressure Vessel (RPV) depressurized by opening valve at the top of RPV.

07:11 Prime Minister arrived at Fukushima Daiichi NPS.

08:04 Prime Minister departed from Fukushima Daiichi NPS.

08:13 Power source cross-ties to Unit 5 from Unit 6 DG via installed cables became possible (for certain DC power sources).

Around 10:15 The 72 power supply cars dispatched by TEPCO and Tohoku Electric confirmed to have arrived in Fukushima (high voltage power supply cars: 12 to Fukushima Daiichi and 42 to Fukushima Daini; low voltage power supply cars: 7 to Fukushima Daiichi and 11 to Fukushima Daini).

14:42 Unit 6 side HVAC of Units 5 and 6 Main Control Room (MCR) emergency HVAC manually activated using power from DG, and air purification inside Units 5 and 6 MCR began.

16:27 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (1,015μSv/h) measured near monitoring post No. 4, and government agencies were notified.

18:25 Prime Minister ordered evacuation of residents within a 20km radius of Fukushima

Daiichi NPS.

March 13, 2011 (Sun.)

08:56 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (882μSv/h) measured near monitoring post No. 4, and government agencies were notified at 09:01.

14:15 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (905μSv/h) measured near monitoring post No. 4, and government agencies were notified at 14:23.

20:48 Power supply to Unit 5 low voltage power panel from Unit 6 DG via temporary cables began.

20:54 Make-up water condensate system (MUWC) pump manually activated.

21:01 Standby gas treatment system (SGTS) manually activated.

March 14, 2011 (Mon.)

02:20 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (751μSv/h) measured near main gate, and government agencies were notified at 04:24.

02:40 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (650μSv/h) measured near monitoring post No. 2, and government agencies were notified at 05:37.

04:00 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (820μSv/h) measured near monitoring post No. 2, and government agencies were notified at 08:00.

05:00 SRV opened to depressurize RPV (intermittently opened thereafter).

05:30 Reactor injection via MUWC began (injection intermittently performed thereafter).

09:12 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (518.7μSv/h) measured near monitoring post No. 3, and government agencies were notified at 09:34.

09:27 Water supply to SFP via MUWC began (supplied as needed thereafter).

21:35 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (760μSv/h) measured near the main gate, and government agencies were notified at 22:35.

March 15, 2011 (Tue.)

05:35 Unified Fukushima NPS Accident Response Headquarters established.

06:50 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (583.7μSv/h) measured near the main gate, and government agencies were notified at 07:00.

08:11 Situation (abnormal radioactive material release due to fire/explosion) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (807μSv/h) measured near the main gate, and government agencies were notified at 08:36.

11:00 Prime Minister ordered retreat to indoor areas for residents within areas between a 20km and 30km radius from Fukushima Daiichi NPS.

16:00 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (531.6μSv/h) measured near the main gate, and government agencies were notified at 16:22.

23:05 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (4,548μSv/h) measured near the main gate, and government agencies were notified at 23:20.

March 16, 2011 (Wed.)

22:16 SFP water exchange began.

March 17, 2011 (Thu.)

05:43 SFP water exchange completed.

March 18, 2011 (Fri.)

13:30 Hole opening work in reactor building(R/B) roof (three areas) finished.

March 19, 2011 (Sat.)

01:55 Residual Heat System (RHR) temporary seawater pump activated using temporary power from power supply cars.

04:22 Second Unit 6 DG activated.

Around 05:00 RHR manually activated (SFP cooling began in emergency heat load mode).

08:58 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (830.8μSv/h) measured near the west gate, and government agencies were notified at 09:15.

March 20, 2011 (Sun.)

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

12:25 RHR manually activated (reactor cooling began in shutdown cooling mode).

14:30 Reactor water temperature dropped to below 100ºC, and reactor entered cold shutdown.

Timeline of major events at Fukushima Daiichi Nuclear Power Station Unit 6 from the occurrence of the earthquake until reactor cold shutdown

[Reference: Unit 6 status at time of earthquake occurrence]

・ Unit 6 was shut down for outage from August 14, 2010.It was in long-term shutdown status due to flammability control system failure. The reactor was in a state of cold shutdown with fuel loaded.

(Reactor pressure: 0MPa, reactor water temperature: approx. 25ºC, spent fuel pool (SFP) temperature: approx. 25ºC)

March 11, 2011 (Fri.)

14:46 **Tohoku-Chihou-Taiheiyo-Oki Earthquake occurred.** Level 3 state of emergency automatically issued.

14:47 Three Emergency Diesel Generators (DG) automatically activated.

15:06 Emergency Disaster Countermeasures Headquarters established at headquarters (for understanding earthquake damage status and restoring power)

15:27 First tsunami wave arrived.

15:35 Second tsunami wave arrived.

15:36 Two DGs tripped.

15:42 Level 1 state of emergency for nuclear disasters issued. Emergency Response Center (ERC) established (joint headquarters with Emergency Disaster Countermeasures Headquarters).

Around 16:00 On-site road soundness checks began.

16:10 Headquarters Distribution Department ordered all station to secure high/low voltage power supply cars and confirm transport routes.

16:36 Level 2 state of emergency issued.

Around 16:50 High/low voltage power supply cars sent from all stations to Fukushima Prefecture in turns.

19:24 On-site road soundness check results reported to station ERC.

20:50 Fukushima Prefecture ordered evacuation of residents within a 2km radius of Fukushima Daiichi NPS.

21:23 Prime Minister ordered evacuation of residents within a 3km radius of Fukushima Daiichi NPS, and retreat to indoor areas for residents within a 3km to 10km radius of said NPS.

Around 22:00 Arrival of one high voltage power supply car of the first group of Tohoku

Electric confirmed.

Around 23:30 Personnel headed towards the field at Unit 5 and Unit 6 to inspect Electrical Power Distribution System.

March 12, 2011 (Sat.)

00:30 Evacuation as per order from the central government for residents confirmed to be completed (evacuation for residents within a 3km radius of Futaba and Okuma Towns confirmed to be completed, re-checked at 01:45)

Around 01:20 Arrival of one TEPCO high voltage power supply car confirmed.

04:55 Site radiation level increase confirmed, and government agencies were notified.

05:44 Prime Minister ordered evacuation of residents within a 10km radius of Fukushima Daiichi NPS.

06:03 Assembly of electrical power distribution system provision line from the Unit 6 DG began.

07:11 Prime Minister arrived at Fukushima Daiichi NPS.

08:04 Prime Minister departed from Fukushima Daiichi NPS.

08:13 Power source cross-ties to Unit 5 from Unit 6 DG via installed cables became possible (for certain DC power sources).

Around 10:15 The 72 power supply cars dispatched by TEPCO and Tohoku Electric confirmed to have arrived in Fukushima (high voltage power supply cars: 12 to Fukushima Daiichi and 42 to Fukushima Daini; low voltage power supply cars: 7 to Fukushima Daiichi and 11 to Fukushima Daini).

14:42 Unit 6 side HVAC of Units 5 and 6 Main Control Room (MCR) emergency HVAC manually activated using power from DG, and air purification inside Units 5 and 6 MCR began.

16:27 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (1,015μSv/h) measured near monitoring post No. 4, and government agencies were notified.

18:25 Prime Minister ordered evacuation of residents within a 20km radius of Fukushima Daiichi NPS.

March 13, 2011 (Sun.)

08:56 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (882μSv/h) measured near monitoring post No. 4, and government agencies were notified at 09:01.

13:01 Make-up water condensate system (MUWC) pump manually activated.

13:20 Reactor injection via MUWC began using power from DG (injection intermittently performed thereafter).

14:15 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (905μSv/h) measured near monitoring post No. 4, and government agencies were notified at 14:23.

20:48 Power supply to Unit 5 low voltage power panel from Unit 6 DG via temporary cables began.

March 14, 2011 (Mon.)

02:20 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (751μSv/h) measured near main gate, and government agencies were notified at 04:24.

02:40 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (650μSv/h) measured near monitoring post No. 2, and government agencies were notified at 05:37.

04:00 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (820μSv/h) measured near monitoring post No. 2, and government agencies were notified at 08:00.

09:12 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (518.7μSv/h) measured near monitoring post No. 3, and government agencies were notified at 09:34.

14:13 Water supply to SFP via MUWC began (supplied as needed thereafter).

21:35 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (760μSv/h) measured near the main gate, and government agencies were notified at 22:35.

March 15, 2011 (Tue.)

05:35 Unified Fukushima NPS Accident Response Headquarters established.

06:50 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (583.7μSv/h) measured near the main gate, and government agencies were notified at 07:00.

08:11 Situation (abnormal radioactive material release due to fire/explosion) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to and radiation levels exceeding 500μSv/h (807μSv/h) measured near the main gate, and government agencies were notified at 08:36.

11:00 Prime Minister ordered retreat to indoor areas for residents within areas between a 20km and 30km radius from Fukushima Daiichi NPS.

16:00 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (531.6μSv/h) measured near the main gate, and government agencies were notified at 16:22.

23:05 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (4,548μSv/h) measured near the main gate, and government agencies were notified at 23:20.

March 16, 2011 (Wed.)

13:10 Fuel pool cooling cleanup water system (FPC) manually activated (circulatory operation with no residual heat removal (RHR) function).

March 18, 2011 (Fri.)

17:00 Hole opening work in R/B roof (three areas) finished.

19:07 DG seawater pump activated.

March 19, 2011 (Sat.)

4:22 Second DG activated.

8:58 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 500μSv/h (830.8μSv/h) measured near the west gate, and government agencies were notified at 09:15.

21:26 RHR temporary seawater pump activated using temporary power from power supply cars.

22:14 RHR manually activated (SFP cooling began in emergency heat load mode).

March 20, 2011 (Sun.)

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

18:48 RHR manually activated (reactor cooling began in shutdown cooling mode).

19:27 Reactor water temperature dropped to below 100ºC and reactor entered cold shutdown.

Response status at Fukushima Daiichi Nuclear Power Station until reactor cold shutdown of Units 5 and 6

○Details of activity from "March 11 14:46 Tohoku-Chihou-Taiheiyo-Oki Earthquake occurred" to "15:27 First tsunami wave arrived"

- See materials "post-disaster response status at Fukushima Daiichi NPS."

○Details of activity from "March 11 15:42 Determining and notifying station black out (SBO)" to "March 20 Cold shutdown (14:30 for Unit 5, 19:27 for Unit 6)"

[Units 5 and 6 MCR status]

- See materials "post-disaster response status at Fukushima Daiichi NPS."
- One of the Unit 6 Emergency Diesel Generators (DG) (6B) was unaffected by the tsunami and remained operational. Since the reactor combination structure high voltage power panel (M/C) was usable, power continued to be supplied to certain emergency equipment (Subsystem B) at Unit 6 after tsunami occurrence.

Units 5 and 6: Unit 6 side

- Since power for lighting and monitoring instruments had been maintained at Unit 6, reactor and SFP parameters could be confirmed.
- Meanwhile, emergency lighting gradually faded out on the Unit 5 side, leaving it in total darkness. Certain monitoring instruments remained operational after SBO, since they received power from DC power sources. The display values needed to perform Unit 5 restoration operation could be checked.

Units 5 and 6: Unit 5 side
(With only emergency lights turned on))

- One HVAC was manually activated at 14:42 on March 12 using power from the Unit 6 DG. This maintained an environment where personnel could stay within the MCR without wearing full face masks.
- Early restoration of off-site power proved difficult. There were concerns over fuel shortage (running out) since all power was being provided solely by one Unit 6 DG. Therefore, fuel (light oil) distribution took place. Said light oil was sent each day to the station from March 18 onward from the Kanto region direction via tanker trucks. DG fuel was maintained by continuing provision to the Unit 6 light oil tank. Tanker trucks were driven to the station by

employees within the evacuation area (later warning area), and light oil tank supplying was also performed by employees (a maximum of 20 trips each day).

[Power source cross-tying from Unit 6 to Unit 5]

Unit 6 electric item room flooding status

Temporary power source cable connection status
(photo taken at later date)

- Lights had gone out in Unit 5 buildings and the inside was pitch black. Operators used flashlights to check the flooding status of the electric item room and power panel usability status. It was confirmed that all Unit 5 high voltage power panels (M/C) were unusable.
- Since Electrical Power Distribution System had been maintained for Unit 6 due to continued DG operation, power source cross-tying between Units 5 and 6 was carried out on 08:13 of March 12. This was done using cables already installed between Units 5 and 6 as Accident Management (AM) measures to provide power to nearby stations. This allowed power to be provided to certain Unit 5 equipment (Subsystem A) which operated on DC power sources.
- By installing temporary power cables directly between the Unit 6 S/B instrument power panel and Unit 5 Control Building instrument power panel, power could be provided to MCR Unit 5 monitoring instruments which could operate on AC power sources.
- Since later Unit 5 high voltage power panel (M/C) flooding meant Unit 5 low voltage power panel (MCC) could not be provided with power, installation of temporary power cables began. These would directly connect the Unit 6 T/B low voltage power panel (MCC) to equipments needed for Unit 5 restoration operation. The Unit 5 standy gas treatment system (SGTS) was activated at 21:01 on March 13 (the Unit 6 SGTS had continued operating after the earthquake). This allowed negative pressure to be maintained at the R/Bs for Units 5 and 6 from then on, and also allowed suppression of radioactive material release in case such release occurred.

[Unit 5 RPV depressurization]

- At the time of earthquake occurrence, Unit 5 was undergoing periodic inspection and RPV pressure resistance leakage tests were being conducted. Reactor water level was full, and reactor pressure was approx. 7MPa.

- The Control Rod Drive (CRD) pump automatically shut down due to loss of power caused by earthquake, and reactor pressure temporarily dropped to 5MPa[gage]. Since reactor pressure gradually rose later due to decay heat, operators attempted depressurization via the RCIC steam line, high pressure coolant injection system (HPCI) steam line, and HPCI exhaust line in that order. However, reactor pressure did not change.
- Reactor pressure continued to gradually rise afterward. Since reactor pressure was maintained at approx. 8MPa, the SRV was deemed to have opened due to releaf valve function. No power was provided to MCR display lights, making SRV operation status confirmation via said lights impossible. However, operators who headed into the field to operate the top of RPV valve air supply line (covered later on) heard noise from SRV operation while inside the R/B.
- It was decided that valves within the R/B would be manually operated to lower reactor pressure. A line to provide nitrogen was assembled so that the top of RPV valve could be opened. The top of RPV valve was opened from the MCR at 06:06 on March 12. This allowed reactor pressure to drop to atmospheric levels.
- Since reactor pressure began gradually rising again due to the effects of decay heat, depressurization operation via the RHR (A) line was performed at 07:31 on March 12. Although swift depressurization was not needed at this time, this operation was performed to secure methods for depressurization. Depressurization via main steam line was attempted from around 00:00 on March 14 onward, but none of these operations changed reactor pressure.
- SRV restoration operation began in the early hours of March 14 in order to lower reactor pressure (in order to perform pressure resistance leakage tests on the SRV, it was set to not allow operation from the MCR). The power source fuse was restored, and the nitrogen gas supply line valve within the reactor PCV was manually operated. Thus was line assembly completed, allowing the SRV to be operated from the MCR. The SRV was opened and RPV depressurization commenced at 05:00 on March 14.

[Alternate reactor injection at Units 5 and 6]

- The restoration team performed soundness checks on the Unit 5 MUWC pump on March 13. Afterwards, temporary power cables were directly installed between said pump and the Unit 6 low voltage power panel (MCC). Power source was restored at 20:48. After reactor depressurization via SRV, the alternate injection line connecting the MUWC and RHR lines used as AM was used to begin reactor injection at 05:30 on March 14.
- The Unit 6 MUWC pump could be activated using power from the Unit 6 DG. AM lines were used to begin reactor injection at 13:20 on March 13.

[Units 5 and 6 SFP temperature increase suppression]

- All seawater pumps at Units 5 and 6 were unusable due to the tsunami. The SFP, which was loaded with spent fuel, could not be cooled.
- SFP water temperature monitoring continued until RHR function restoration. This took place after evaluating the rate of SFP decay heat temperature increase.
- Since the Units 5 and 6 MUWC pumps had been restored, AM lines were used to fill the SFP nearly to capacity on March 14.
- After the portions of Unit 5 SFP water which increased in temperature were drained, AM lines were used to provide the MUWC pump with water on March 16. This was done to suppress the rate of SFP water temperature increase until RHR function restoration.
- Since the Unit 6 FPC pump was powered by the Unit 6 DG, said pump was activated in circulation operation (no RHR function) on March 16. SFP water was agitated in order to suppress the rate of SFP water temperature increase.

[Units 5 and 6 RHR function restoration]

- Due to periodic inspection, Unit 5 had been in shutdown for approx. 2.5 months, while Unit 6 had been in shutdown for approx. 7 months. Decay heat within the reactor at the time of earthquake was relatively less than that of operating plants.
- The restoration team performed soundness check of the Units 5 and 6 RHR seawater pumps and discovered they were unusable. In coordination with the headquarters, they deliberated temporarily connecting the general use underwater pump to seawater system pipes for restoration as an alternate RHR cooling seawater pump.
- Underwater pump installation area rubble removal and leveling for construction roads began on March 16. Installation of temporary power cables from the high voltage power supply cars, outdoor pump operation panel installation, and temporary underwater pump installation were completed on March 18 for Unit 5 and on March 19 for Unit 6. The temporary RHR seawater pump was activated at 01:55 on March 19 for Unit 5 and at 21:26 of the same day for Unit 6.

Underwater pump installation work

Underwater pump installation status
(installation took place on later date)

・ Since power could not be provided to the Unit 5 RHR pump via Unit 5 high voltage power panel (M/C) due to tsunami flooding of the T/B basement floor, approx. 200m of temporary power cables were installed from the Unit 6 high voltage power panel (M/C) on March 18. This provided the Unit 5 RHR pump with DC power.

・ Power was provided to the Unit 6 RHR pump since the Unit 6 DG high voltage power panel (M/C) bore the load.

・ Due to the restoration of the RHR pump and RHR seawater pump, one RHR function parallel became usable for Units 5 and 6. It was decided that the reactor and SFP would be cooled alternately via switching of RHR system configuration.

・ After SFP water temperature dropped, the RHR system configuration was switched to transition to reactor cooling. Reactor water temperature dropped to below 100ºC, and the reactor entered cold shutdown (at 14:30 on March 20 for Unit 5 and at 19:27 on March 20 for Unit 6).

・ The Unit 5 FPC pump was activated at 16:35 on June 24, and the SFP was cooled via said pump, while the reactor was cooled via the RHR.

[Preventing hydrogen gas accumulation within the R/Bs of Units 5 and 6]

・ Reactor and SFP water levels were maintained after earthquake occurrence, and hydrogen gas was not generated at this time. However, due to the risk of injection function and RHR function loss due to aftershocks, the station ERC deliberated hydrogen gas accumulation prevention measures just in case. It was decided that boring machines would be used to open holes in three areas (diameters ranging from approx. 3.5cm to approx. 7cm) in the concrete roofs of the R/Bs for Units 5 and 6 on March 18.

Work on the rooftop

・ Work began in the early morning hours of March 18. 4 employees and 4 contractor workers wore full face masks with charcoal filters and coveralls before climbing on the rooftop of the R/B, and worked a total of approx. 11 hours on Units 5 and 6 (Unit 5 work completed at 13:30 and Unit 6 work completed at 17:00).

[Unit 6 DG restoration]

・ The seawater pump for Unit 6 DG (6A) cooling was covered by seawater during tsunami. Operators and the restoration team confirmed

Seawater pump area status

(circled area is DG (6A) seawater pump)

pump soundness via visual checks of outdoor seawater pump area flooding and external damage status, alongside insulation resistance measurement. The pump was activated at 19:07 on March 18.

- The Unit 6 DG (6A) was activated at 04:22 on March 19. This meant two DGs were functional as emergency power to Units 5 and 6.

End

Timeline of major events at Fukushima Daini Nuclear Power Station Unit 1 from the occurrence of the earthquake until reactor cold shutdown

March 11, 2011 (Fri.)

14:46 **Tohoku-Chihou-Taiheiyo-Oki Earthquake occurred.** Level 3 state of emergency automatically issued.

14:48 **Reactor entered automatic scram.**

14:48 One Tomioka line shut down (power continued to be received via the other line).

15:00 Reactor confirmed to be subcritical.

15:06 Emergency Disaster Countermeasures Headquarters established at headquarters (for understanding earthquake damage status and restoring power)

15:22 **First tsunami wave confirmed (tsunami intermittently confirmed thereafter until 17:14).**

15:33 Circulating Water Pump (CWP) (C) manually shut down.

15:34 Emergency Diesel Generator (DG) (A) (B) (H) automatically activated, and shut down soon after due to tsunami impact.

15:36 Main Steam Isolation Valve (MSIV) manually set to fully closed position.

15:36 Reactor Core Isolation Cooling System (RCIC) manually activated (activated and shut down as needed thereafter).

15:50 All Iwaido lines shut down.

15:55 Reactor depressurization began (safety relief valve (SRV) opened) (repeated opening and closing thereafter to control reactor pressure).

15:57 CWP (A) (B) automatically shut down.

17:35 **Situation (reactor coolant leakage) deemed to fall under Article 10, Section 1 of the Act on Special Measures Concerning Nuclear Emergency Preparedness (hereinafter referred to as "Nuclear Emergency Act") due to the possibility that reactor coolant leakage within Primary Containment Vessel (PCV) was the cause of pressure increase based on "Dry Well (D/W) pressure high" alarm activation and alarm typer records showing "MSIV low reactor water level (L-2)," and government agencies were notified at 17:50** (later, relevant parameter checks revealed reactor coolant leakage did not occur, and thus the situation was deemed inapplicable around 18:33 on the same day).

17:53 D/W cooling system manually activated.

18:33 **Situation (reactor heat removal function loss) deemed to fall under Article 10, Section 1 of the Nuclear Emergency Act due to inability to confirm activation of**

reactor heat removal function equipment (RHR equipment cooling seawater system pump, RHR equipment cooling system pumps, Emergency Diesel Generator cooling system pump), and government agencies were notified at 18:49.

March 12, 2011 (Sat.)

00:00 Alternate injection via make-up water condensate system (MUWC) began.

03:50 Rapid reactor depressurization began.

04:56 Rapid reactor depressurization completed.

04:58 RCIC manually isolated.

05:22 Situation (pressure suppression function loss) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to Suppression Chamber (S/C) temperature rising to over 100ºC, and government agencies were notified at 05:48.

06:20 S/C cooling performed using Flammability Control System (FCS) coolant (MUWC).

07:10 D/W spray performed using MUWC (performed as needed thereafter).

07:37 S/C spray performed using MUWC (performed as needed thereafter).

07:45 Prime Minister ordered evacuation of residents within a 3km radius of Fukushima Daini Nuclear Power Station (NPS), and retreat to indoor areas for residents within a 10km radius of said NPS.

07:45 S/C cooling using FCS coolant (MUWC) halted.

10:21 PCV pressure resistant venting line assembly began.

13:38 One Iwaido line receiving power.

14:05 Evacuation as per order from the central government for residents confirmed to be completed (evacuation for residents within a 3km radius of Naraha and Tomioka Towns confirmed to be completed).

17:39 Prime Minister ordered evacuation of residents within a 10km radius of Fukushima Daini NPS.

18:30 PCV pressure resistant venting line assembly completed.

March 13, 2011 (Sun.)

05:15 Two Iwaido lines receiving power.

20:17 RHR equipment cooling seawater system pump (B) manually activated.

21:03 RHR equipment cooling system pump (D) manually activated.

March 14, 2011 (Mon.)

01:24 **RHR pump (B) manually activated (S/C cooling mode began).Situation (reactor heat removal function loss) deemed to no longer fall under Article 10, Section 1 of the Nuclear Emergency Act due to activation of RHR (B).**

01:44 Emergency Diesel Generator cooling system pump (B) manually activated.

03:39 RHR (B) S/C spray mode began.

10:05 Reactor injection with RHR (B) low pressure injection mode began.

10:15 **Deemed to have recovered from situation (pressure suppression function loss) under Article 15, Section 1 of the Nuclear Emergency Act due to S/C temperature dropping to below 100ºC, and government agencies were notified at 10:35.**

17:00 **Reactor water temperature dropped to below 100ºC, and reactor entered cold shutdown.**

Timeline of major events at Fukushima Daini Nuclear Power Station Unit 2 from the occurrence of the earthquake until reactor cold shutdown

March 11, 2011 (Fri.)

14:46 **Tohoku-Chihou-Taiheiyo-Oki Earthquake occurred.** Level 3 state of emergency automatically issued.

14:48 **Reactor entered automatic scram.**

14:48 One Tomioka line shut down. (power continued to be received via the other line).

15:01 Reactor confirmed to be subcritical.

15:06 Emergency Disaster Countermeasures Headquarters established at headquarters (for understanding earthquake damage status and restoring power)

15:22 **First tsunami wave confirmed (tsunami intermittently confirmed thereafter until 17:14).**

15:34 Emergency Diesel Generator (DG) (H) automatically activated, and shut down soon after due to tsunami impact.

15:34 Main steam isolation valve (MSIV) manually set to fully closed position.

15:35 Residual Heat System (RHR) pump (B) manually activated (15:38 automatic shutdown).

15:35 Circulating Water Pump (CWP) (C) manually shut down, and CWP (A) (B) automatically shut down.

15:41 DG (A) (B) automatically activated, and shut down soon after due to tsunami impact.

15:41 Reactor depressurization began (safety relief valve (SRV) opened) (repeated opening and closing thereafter to control reactor pressure).

15:43 Reactor Core Isolation Cooling System (RCIC) manually activated (activated and shut down as needed thereafter).

15:50 All Iwaido lines shut down.

18:33 **Situation (reactor heat removal function loss) deemed to fall under Article 10, Section 1 of the Nuclear Emergency Act due to inability to confirm activation of reactor heat removal function equipment (RHR equipment cooling seawater system pump, RHR equipment cooling system pumps, Emergency Diesel Generator cooling system pump), and government agencies were notified at 18:49.**

20:02 D/W cooling system manually activated.

March 12, 2011 (Sat.)

04:50 **Alternate injection via make-up water condensate system (MUWC) began.**

04:53 RCIC automatically isolated.

05:32 Situation (pressure suppression function loss) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to Suppression Chamber (S/C) temperature rising to over 100ºC, and government agencies were notified at 05:48.

06:30 S/C cooling performed using Flammability Control System (FCS) coolant (make up water system (purified) (MUWP)).

07:11 D/W spray performed using MUWC (performed as needed thereafter).

07:35 S/C spray performed using MUWC (performed as needed thereafter).

07:45 Prime Minister ordered evacuation of residents within a 3km radius of Fukushima Daini NPS, and retreat to indoor areas for residents within a 10km radius of said NPS.

07:52 S/C cooling using FCS coolant (MUWP) halted.

10:33 Primary containment vessel (PCV) pressure resistant venting line assembly began.

10:58 PCV pressure resistant venting line assembly completed.

13:38 One Iwaido line receiving power.

14:05 Evacuation as per order from the central government for residents confirmed to be completed (evacuation for residents within a 3km radius of Naraha and Tomioka Towns confirmed to be completed).

17:39 Prime Minister ordered evacuation of residents within a 10km radius of Fukushima Daini NPS.

March 13, 2011 (Sun.)

05:15 Two Iwaido lines receiving power.

March 14, 2011 (Mon.)

03:20 Emergency Diesel Generator cooling system pump (B) manually activated.

03:51 RHR equipment cooling seawater system (B) manually activated.

05:52 RHR equipment cooling system (B) manually activated.

07:13 RHR pump (B) manually activated (S/C cooling mode began). Situation (reactor heat removal function loss) deemed to no longer fall under Article 10, Section 1 of the Nuclear Emergency Act due to activation of RHR (B).

07:50 RHR (B) S/C spray mode began.

10:48 Reactor injection with RHR (B) low pressure injection mode began.

15:52 Deemed to have recovered from situation (pressure suppression function loss) under Article 15, Section 1 of the Nuclear Emergency Act due to S/C temperature dropping to below 100ºC, and government agencies were notified at 16:15.

18:00 Reactor water temperature dropped to below 100ºC, and reactor entered cold shutdown.

Timeline of major events at Fukushima Daini Nuclear Power Station Unit 3 from the occurrence of the earthquake until reactor cold shutdown

March 11, 2011 (Fri.)

14:46 **Tohoku-Chihou-Taiheiyo-Oki Earthquake occurred.** Level 3 state of emergency automatically issued.

14:48 **Reactor entered automatic scram.**

14:48 One Tomioka line shut down (power continued to be received via the other line).

15:05 Reactor confirmed to be subcritical.

15:06 Emergency Disaster Countermeasures Headquarters established at headquarters (for understanding earthquake damage status and restoring power)

15:22 **First tsunami wave confirmed (tsunami intermittently confirmed thereafter until 17:14).**

15:34 Circulating Water Pump (CWP) (C) manually shut down.

15:35 Emergency Diesel Generator (DG) (A) (B) (H) automatically activated, and shut down soon after due to tsunami impact.

15:36 Residual Heat System (RHR) pump (B) manually activated (Suppression Chamber (S/C) cooling mode began).

15:37 Main steam isolation valve (MSIV) manually set to fully closed position.

15:38 CWP (B) manually shut down.

15:46 Reactor depressurization began (safety relief valve (SRV) opened) (repeated opening and closing thereafter to control reactor pressure).

16:06 Reactor core isolation cooling system (RCIC) manually activated.

16:48 CWP (A) manually shut down.

20:12 Dry Well (D/W) cooling system manually activated.

22:53 **Alternate injection via make-up water condensate system (MUWC) began.**

23:58 RCIC manually isolated.

March 12, 2011 (Sat.)

00:06 RHR (B) reactor shutdown cooling (SHC) mode assembly preparations began.

01:23 RHR pump (B) manually shut down (as part of SHC mode preparations).

02:39 RHR pump (B) manually activated (S/C cooling mode began).

02:41 RHR (B) S/C spray mode began.

07:45 Prime Minister ordered evacuation of residents within a 3km radius of Fukushima Daini NPS, and retreat to indoor areas for residents within a 10km radius of said NPS.

07:59 RHR pump (B) manually shut down (S/C cooling mode and S/C spray mode halted).

09:37 RHR pump (B) manually activated (SHC mode operation began).

12:08 Primary containment vessel (PCV) pressure resistant venting line assembly began.

12:13 PCV pressure resistant venting line assembly completed.

12:15 Reactor water temperature dropped to below 100ºC, and reactor entered cold shutdown.

Timeline of major events at Fukushima Daini Nuclear Power Station Unit 4 from the occurrence of the earthquake until reactor cold shutdown

March 11, 2011 (Fri.)

14:46 **Tohoku-Chihou-Taiheiyo-Oki Earthquake occurred.** Level 3 state of emergency automatically issued.

14:48 **Reactor entered automatic scram.**

14:48 One Tomioka line shut down (power continued to be received via the other line).

15:05 Reactor confirmed to be subcritical.

15:06 Emergency Disaster Countermeasures Headquarters established at headquarters (for understanding earthquake damage status and restoring power)

15:22 **First tsunami wave confirmed (tsunami intermittently confirmed thereafter until 17:14).**

15:33 Circulating Water Pump (CWP) (C) manually shut down.

Around 15:34 Emergency Diesel Generators (DG) (A) (B) (H) automatically activated, and DG (A) (B) shut down soon after due to tsunami impact.

15:35 CWP (A) (B) automatically shut down.

15:36 Main steam isolation valve (MSIV) manually set to fully closed position.

15:36 Residual Heat System (RHR) pump (B) manually activated (15:41 automatic shutdown).

15:37 RHR pump (A) manually activated (15:38 manual shutdown).

15:46 Reactor depressurization began (safety relief valve (SRV) opened) (repeated opening and closing thereafter to control reactor pressure).

15:50 All Iwaido lines shut down.

15:54 RCIC manually activated (activated and shut down as needed therafter).

18:33 **Situation (reactor heat removal function loss) deemed to fall under Article 10, Section 1 of Nuclear Emergency Act due to inability to confirm activation of reactor heat removal function equipment (RHR equipment cooling seawater system pump, RHR equipment cooling system pumps, Emergency Diesel Generator cooling system pump), and government agencies were notified at 18:49.**

19:14 Dry well (D/W) cooling system manually activated.

March 12, 2011 (Sat.)

00:16 **RCIC automatically isolated. Alternate injection via make-up water condensate**

system (MUWC) began.

06:07 Situation (pressure suppression function loss) deemed to fall under Article 15, Section 1 of the Nuclear Emergency Act due to Suppression Chamber (S/C) temperature rising to over 100ºC, and government agencies were notified at 06:18.

07:23 S/C cooling performed using Flammability Control System (FCS) coolant (make up water system (purified) (MUWP)).

07:35 S/C spray performed using MUWC.

07:45 Prime Minister ordered evacuation of residents within a 3km radius of Fukushima Daini NPS, and retreat to indoor areas for residents within a 10km radius of said NPS.

11:17 High Pressure Core Spray (HPCS) pump activated (S/C agitation operation began)

11:44 Primary Containment Vessel (PCV) pressure resistant venting line assembly began.

11:52 PCV pressure resistant venting line assembly completed.

12:32 Reactor injection switched from MUWC (alternate injection) to HPCS.

13:38 One Iwaido line receiving power.

13:48 HPCS pump shut down (activated and shut down as needed thereafter).

14:05 Evacuation as per order from the central government for residents confirmed to be completed. (evacuation for residents within a 3km radius of Naraha and Tomioka Towns confirmed to be completed).

17:39 Prime Minister ordered evacuation of residents within a 10km radius of Fukushima Daini NPS.

March 13, 2011 (Sun.)

05:15 Two Iwaido lines receiving power.

March 14, 2011 (Mon.)

11:00 Emergency Diesel Generator cooling system pump (B) manually activated.

13:07 RHR equipment cooling seawater system pump (D) manually activated.

14:56 RHR equipment cooling system pump (B) manually activated.

15:42 RHR pump (B) manually activated (S/C cooling mode began). Situation (reactor heat removal function loss) deemed to no longer fall under Article 10, Section 1 of Nuclear Emergency Act due to activation of RHR (B).

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

18:58 Reactor injection with RHR (B) low pressure injection mode began (injection halted at 19:20) (reactor injection performed as needed thereafter).

22:07 Situation (abnormal site boundary radiation level increase) deemed to fall under

Article 10, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 5μGy/h measured at monitoring post (No. 1), and government agencies were notified at 22:13 (cause of dose increase assumed to be atmospheric radioactive material release accompanying accident at Fukushima Daiichi NPS).

March 15, 2011 (Tue.)

00:12 Situation (abnormal site boundary radiation level increase) deemed to fall under Article 10, Section 1 of the Nuclear Emergency Act due to radiation levels exceeding 5μGy/h measured at monitoring post (No. 3), and government agencies were notified at 00:16 (cause of dose increase assumed to be atmospheric radioactive material release accompanying accident at Fukushima Daiichi NPS).

07:15 Deemed to have recovered from situation (pressure suppression function loss) under Article 15, Section 1 of the Nuclear Emergency Act due to S/C temperature dropping to below 100ºC, and government agencies were notified at 07:35.

07:15 Reactor water temperature dropped to below 100ºC, and reactor entered cold shutdown.

Response status at Fukushima Daini Nuclear Power Station until reactor cold shutdown

<u>○ Details of activity from “March 11 14:46 Tohoku-Chihou-Taiheiyo-Oki Earthquake occurred” to “15:22 First tsunami wave confirmed"</u>

[Evacuation and confirmation of personnel safety]

- Personnel in the main office building were evacuated to the parking lot, and their safety was confirmed there. Afterwards, personnel performing response measures went to the seismic isolated building to begin performing said measures, while all other employees evacuated to the grounds.

[Scram response operation]

- Due to large shaking during earthquake occurrence, operators went into standby while crouching and holding onto rails on the front of the control panels. The Shift Supervisor predicted scram would occur, and ordered operators to begin scram response operations as soon as shaking stopped.
- The Deputy Shift Supervisor informed all personnel of earthquake occurrence and ordered evacuation via mass paging. Operators in the field were contacted and ordered to evacuate using cellphones.
- Reactor automatic scram was confirmed at each Main Control Room (MCR) at 14:48. It was later confirmed that reactors were subcritical.
- The Shift Supervisor determined that operators could not hear orders due to the various alarms (including the fire alarm) that had activated. Therefore, the Shift Supervisor used the portable microphone distributed behind their chair as part of emergency materials to give orders (fire alarm later determined to have activated erroneously).
- The Shift Supervisor received reports of large tsunami alert issuance from the station ERC. They ordered emergency evacuation due to large tsunami alert issuance via mass paging.

[Status of off-site power supply]

- Off-site power equipment is comprised of four lines (two Tomioka lines and two Iwaido lines). Prior to earthquake occurrence, said equipment was comprised of three lines (excluding one Iwaido line).
- After earthquake occurrence, one Tomioka line shut down at 14:48 and one Iwaido line shut down (due to Shin Fukushima Substation equipment malfunction) at 15:50. Power provision continued via the one remaining Tomioka line.
- One Iwaido line was restored at 13:38 on March 12 and another Iwaido line was restored at

05:15 on March 13. Thus off-site power returned to a three line composition (the last Tomioka line was restored and began providing power at 17:43 on April 15).

○Details of activity from "March 11 15:22 First tsunami wave confirmed" to "reactor entered cold shutdown"

[Post-tsunami arrival response operation]

・ It was confirmed via field monitoring cameras that tsunamis were approaching towards the seawall and the circulating water pump (CWP) was halfway submerged (confirmed from Units 1 and 2 MCR and Units 3 and 4 MCR respectively).

・ After the tsunami, all or some of the alarms for each Unit on their MCR control panel turned off, then on, then off again repeatedly. Station status could still be monitored, however. Approx. half of the parameter monitoring/equipment operational state checking instruments and display lights for Unit 1 were secured, and all instruments and display lights for Units 2, 3 and 4 were secured.

・ The Shift Supervisor gave orders to continue monitoring the situation (mainly from reactor system control panels), and distributed operators to control panels where operation status of seawater system equipment vital for reactor heat removal (seawater and coolant pumps) (hereinafter referred to as "ECS Pumps") could be monitored. They were instructed to give information as needed.

MCR after tsunami

・ Shutdown of operating ECS pumps was confirmed at MCRs via operation/shutdown status display lights.

・ CWP was shut down for each Unit according to tsunami response procedures. Since steam could no longer be condensed by the condenser due to this, the MSIV was fully closed. Reactor injection via RCIC and reactor pressure control (depressurization operation) via main steam SRV was begun.

Water damaged cool ing water pump
(photo taken at later date)

[Operation response up to reactor cold shutdown]

<Alternate injection via MUWC>

・ The RHR equipment used to perform reactor injection cooling and possess RHR function after reactor depressurization could not be activated (excluding Unit 3) due to tsunami impact rendering ECS Pumps unusable. Therefore, preparations for alternate injection via MUWC (introduced as Accident Management (AM)) were begun, in addition to reactor injection cooling for each Unit after RCIC shutdown. Line assembly via valve operation from MCR AM panels was performed at Units 2, 3 and 4. Since the drive power for valves necessary for line assembly at Unit 1 were lost due to tsunami, valves were manually opened in the field. After line assembly was completed, the intake valve was opened from the MCR and it was confirmed that injection was possible.

Valve operation with the MCR AM panels
(work conditions shown took place on later date)

- The RCIC was later shut down due to reactor pressure drop, but reactor water level was secured without incident due to alternate injection via MUWC.
- The HPCS was activated at Unit 4 on March 12 and reactor injection switched from MUWC to HPCS. Reactor water level was controlled from then onward by repeatedly starting up/shutting down the HPCS.

<PCV pressure increase suppression measures>

- ECS Pumps at Units 1, 2 and 4 were unusable because their heat exchanger buildings (Hx/Bs) were flooded by the tsunami. Since reactor RHR function equipment became unusable as a result, the situation (reactor heat removal function loss) was deemed to fall under Article 10 of Act on Special Measures Concerning Nuclear Emergency Preparedness (hereinafter referred to as “Nuclear Emergency Act”) at 18:33 on March 11. As RHR equipment also performed S/C cooling, this meant S/C cooling was also impossible. S/C temp. and pressure had risen due to reactor injection via RCIC and reactor depressurization via SRV, and S/C temp. finally exceeded 100ºC on the morning of March 12. Therefore, the situation (pressure suppression function loss) was deemed to fall under Article 15 of the Nuclear Emergency Act. The station ERC deliberated on methods to cool the S/C. The Shift Supervisor acted according to station ERC orders, and ordered operators to perform S/C cooling via either MUWC or MUWP using the FCS cooling equipment runoff line (runs to S/C). This was performed beginning with Units where preparations had been completed.
- Reactor alternate injection via MUWC was switched as appropriate to D/W spray or S/C spray to work toward suppressing PCV pressure increase.
- The Units 1 and 2 MCR manually activated the D/W cooling system (no cooling source), in hopes it would suppress PCV pressure increase. The Units 3 and 4 Shift Supervisor was notified that D/W temp. dropped after activation, and they carried out response accordingly. The Units 3 and 4 Shift Supervisor then confirmed that D/W temp. had indeed dropped.

<PCV pressure resistant venting preparations>

- The station ERC understood that PCV pressure showed signs of rising since they received information on station parameters (e.g. reactor water level, D/W pressure) via communication (cellphones) with the MCR. Since reactor RHR function restoration at Units 1, 2 and 4 was predicted to take some time, it was decided that PCV pressure resistant venting line assembly (where one action of S/C side outlet valve opening would be left) would be performed. In case of Unit 3 PCV pressure increase, it was decided that PCV pressure resistant venting line assembly would be performed in line with other Units.
- For Units 2, 3 and 4, completing assembly of the abovementioned lines via MCR switch operation took somewhere between 5 to 25 min. At Unit 1, however, loss of power to the pressure resistant venting line inlet valve (AO valve) drive air control solenoid valve due to tsunami impact meant that valve could not be opened. Therefore, the station ERC deliberated on response measures (methods to directly connect small tanks to the valve drive part, as well as methods to restore power to the aforementioned solenoid valve so it could be opened). Considering PCV pressure increase trends, it was predicted there would be some leeway until pressure resistant venting preparation completion. It was decided that power to the solenoid valve in question would be restored so it could be opened. Power source routes were checked at 16:00 on March 12 and electric circuit assembly was completed. Opening operation of the pressure resistant venting line inlet valve was performed at 18:30. It was confirmed to have opened, and thus the assembly of the PCV pressure resistant venting line was completed.

<Securing reactor RHR function>

- Around 20:00 on March 11, the station ERC ordered equipment soundness checks which gave sufficient consideration to safety. Therefore, operators and the station ERC restoration team began field checks. Operators had to deliberately place themselves in harm's way to perform field checks, as field conditions were by no means safe. Lights had gone out in the Hx/B, making the inside pitch black and meaning operators only had flashlights to guide them. Water was left from flooding, where floating debris and trash blocked the way. A tsunami alert was still in effect, and operators had to evacuate to high ground each time an aftershock occurred. Based on the equipment status and power source water damage conditions confirmed in this way, inspection/maintenance priority of ECS Pump equipment for each Unit was determined by the station ERC.
- It was decided that the temporary cables needed for power restoration would be transported from off-site via helicopter. The grounds and baseball field were quickly chosen as landing

sites, and preparations (e.g. removing fences around the baseball field and setting up twenty employee cars to provide helicopter guide lights) continued through the night into the early hours of March 12. Trucks were also used at this time to transport temporary cables, despite road conditions being poor due to the effects of the earthquake.

- Temporary cables were installed between various areas to restore power to necessary equipment. These included: from the radwaste building (hereinafter referred to as “RW building”) to the Hx/B of Units 1 and 2; from the Unit 3 Hx/B to the Hx/B of Units 2 and 4; from high voltage power supply cars to the Hx/B of Units 1 and 4 via the transformer temporarily stored in the Unit 3 T/B truck bay. The priority for power restoration was decided based on station status evaluations made upon consideration of trends in parameters at each Unit (e.g. D/W pressure). As a result, Unit 2 was initially given priority and cable installation began accordingly. However, due to evaluation based on later parameter trend changes, this was changed to prioritize Unit 1 power restoration.

Temporary cable installation preparations
(work conditions shown took place on later date)

- Temporary cable installation was performed by teams of approx. 40 personnel. These teams were comprised of a mix of employees, on-site contractors, and personnel gathered from the Distribution Dept. (employees and contractors) of each branch. Work took place amidst aftershocks and scattered tsunami debris. Depending on the Unit, work sometimes took place at night, and in those cases, headlights were used since work was performed in total darkness.
- The temporary cables were each 2 to 3cm thick, bundled into groups of three. If length of these groups were approx. 200m, then the weight would be over 1t. Between the RW building and Hx/B, cables spanning a max. of approx. 800m had to be installed. Work that would normally be performed over several days using machinery had to be performed quickly using only manpower. The total length of installed temporary cable was 9km. Some of it was installed on March 12, and installation of the remaining majority on March 13.
- Motor cleaning for certain Unit 1 ECS Pumps was performed, but their insulation resistance failed to recover. Therefore, motors were airlifted in by the Self Defense Force (SDF) from Mie Prefecture to Fukushima Airport. After the motors arrived at the station from the Airport, installation and connection to temporary cables began immediately. Work was

Pump motor restoration work
(work conditions shown took place on later date)

completed by the evening of March 13.

- Since insulation resistance for the motors of certain Unit 4 ECS Pumps failed to recover, motor disassembly inspection took place alongside replacement work. It was discovered through disassembly inspection that extant motors were unusable, and it was therefore decided that motors transported from Kashiwazaki-Kariwa NPS would be used instead. Bringing these motors to Unit 4 proved difficult, as the doors of the Unit 4 Hx/B had to be broken since they refused to open.
- The ECS Pumps at Units 1, 2 and 4 were each started up as soon as their restorations were completed. Later, the still sound RHR pump was activated. This restored reactor RHR function, and the situation (reactor heat removal function loss) was deemed to have been restored from one falling under Article 10 of the Nuclear Emergency Act.
- Furthermore, S/C cooling via the restored RHR allowed S/C temp. to fall below 100ºC, and the situation (pressure suppression function loss) was deemed to have been restored from one falling under Article 15 of the Nuclear Emergency Act. Reactor injection was performed afterwards, and since reactor water temp. fell below 100ºC, the reactor was confirmed to have entered cold shutdown.
- Reactor cooling was performed at Unit 3 using the RHR, since it avoided the effects of the tsunami and was confirmed to be sound. Reactor water temp. fell below 100ºC on March 12, and the reactor was confirmed to have entered cold shutdown.

End

Voices from the Field

On March 11, 2011 an earthquake resulted in a tsunami that caused station black out thereby forcing workers to respond amidst the harshest of circumstances.

When investigating the facts related to the response to this accident, interviews with workers shed light on the severity and hardships experienced while engaging in work in the field.

The following are firsthand accounts from the workers themselves. These accounts are based on recollection and therefore may contain details that are not proven fact. However, these accounts are deemed useful in that they help the reader to better understand the circumstances surrounding the response to this accident.

[Conditions in the main control rooms and conditions when inspecting the field]

○ At the time when the tsunami arrived I saw **the lamps on the Unit 1 and 2 power panels flicker and then all go out at once**. The D/G stopped and lamps started to go out one by one, I had no idea what was happening. In the main control room (MCR) the lights on the **Unit 2 side went completely out and the Unit 1 side was lit by emergency lighting (very dim lighting).** All the alarms went off and for a moment the entire MCR was silent. I think this happened on the Unit 2 side first. **I doubted whether what I was seeing was indeed reality or not.**

○ I have no memory of at what point in time this happened, but **some operators returned to the MCR yelling, "Oh no! Seawater is flooding in!"** at which point I thought to myself that seawater was being washed in by the tsunami.

○ This is something I heard from field operators that had gone into the field to restore the RPS (reactor protector system) MG set (motor/generator set). The operators had immediately returned when they couldn't start up Unit 1. They started up Unit 2 and **then hurried up the stairs after hearing an unbelievable roar from the basement. Water was coming in from the S/B (service building) entrance. They evacuated from the location while getting drenched.**

○ When we were about halfway down the corridor (turbine building basement corridor) the fire alarm went off and we turned back sensing danger. Then **suddenly the lights went out and we could hear that the D/G had stopped.** We just started running, passed the M/C room and up the stairs when suddenly **a large amount of water started pouring through the airtight door to the D/G room.**

- For some reason the door connecting Unit 1 and Unit 2, which is always open, was closed and could not be opened by one person, so two of us pushed it open. **As soon as we opened the door water flooded in up to our waists. We waded through it as I thought to myself for the first time that the tsunami had arrived.** There was about 80cm of water in the first floor of the S/B (service building) and various objects were floating about. We returned to the MCR drenched and gave a summary of what we had seen.
- With the power out I felt more of a sense of helplessness than fear. Young operators looked uneasy. **Some started yelling, "We can't do anything, there is no reason for us to be here, why do we have to stay!?"** (*In response to being asked about how the situation resolved itself)* I bowed my head and said, "Please stay" at which point another shift supervisor also bowed his head in silence. **We told two young trainees to evacuate to the seismic isolated building and asked for a nod of approval from everyone else.**
- Since nothing else could be done at the time I told workers to go get some emergency food (hard biscuits) and water and eat; an effort to get them to calm down a little.
- Some workers asked what was going to happen to them if they stay, and others said nothing but I'm sure were thinking the same thing. **There are even those who fell ill and had to lie down and have still not returned to work (*at the time of interview*)**.
- Until the point in time when we could check parameters, **it was as if we had lost all of our five senses.**
- We had undergone extensive training but none of that was applicable. **It was as if we had had our legs and arms cut off and were just sitting there looking at the data that was available.** Then when the first hydrogen explosion occurred **some people start to lose it.**
- In the MCR, **in an effort to lower exposure doses I had shift workers come from the Unit 1 side to the Unit 2 side and squat down.** This was the situation from the night of the 11th until the morning. **I could see in the**

eyes of some chief engineers that they were starting to feel uneasy as well.

- **After the explosions three members fell ill and had to lie down, and were unable to get up thereafter.**
- **There was no information and I had no idea what the status of the plant was. I felt like if I didn't keep busy I would lose my mind, so I kept looking for one thing to do after another.** I think the only reason why I could continue to work is because I didn't know exactly what was going on.
- I discovered water coming in through the truck bay and peeked in to see water flooding in from underneath the shutter. Immediately after that t**he shutter burst open and the tsunami rushed into the building. The two of us ran away but couldn't stop shaking with fear.**
- We tried to get into the common building in order to check the status of operation of the 4B D/G, **but got trapped inside the entrance gate.** We tried to contact security personnel but to no avail, **and 2 to 3 min. later the tsunami arrived. The water started to flood in from beneath and I thought that I was going to die,** at which point the glass of the gate of a veteran employee who was in the same situation shattered and he was able to escape. He broke the glass of my gate and I was able to escape as well. **Right before I was saved the water was up to my chin and I was quite scared.**
- In order to check the state of things I entered the new S/B (service building) and when I looked from the windows towards the ocean I **could see a sheet of white spray off in the distance. I thought I might be in trouble so I did not go up to the second and third floor but rather just opened the door and shouted in. Sensing danger I left the new S/B (service building) and when I looked to my left I could see the tsunami rushing in from the Unit 4 side. Then, I saw a column of water several tens of meters high** overcome the steel plate of the intake or outlet inspection port in front of Unit 4 **and was frozen in my tracks.** I knew I had to get from the new S/B (service building) to the S/B (service building in which the MCR is located. It is on the Unit 4 side from the new S/B) so **I ran towards the tsunami. It was a really close call.** I knew I had to run towards the tsunami or I wouldn't make it to the MCR.
- Before going into the field I took my ring off because I knew that if it was contaminated I wouldn't be able to leave with it, but then **I put it on again**

thinking to myself that if the worst did happen they might need it to identify my body, and also kept it as a good luck charm.

- ○ **The MCR and the field was completely dark, I didn't know if my family was safe, and I didn't know what was happening outside (I couldn't watch the news) so I was quite uneasy.**
- ○ In the absence of power wireless phones and pagers were useless, so when dropping load in the cable bolt room we had to have people line up from the MCR to the cable room to act as a relay system for communication. We had about five people positioned at the entrance to the MCR, the cafeteria, the locker room, and the cable bolt room. **Sometimes we used many people with each person running over a distance of about 50m back and forth in the turbine building.**
- ○ Radiation levels in the Unit 3 and 4 MCR quickly rose after the Unit 1 explosion. We had first thought that the hydrogen inside the generator in Unit 1 had exploded so we were perplexed as to why outside radiation levels were rising. **The only means of communication we had was a hotline at the shift supervisor’s desk, so we had no information about what was happening outside the MCR and we were very uneasy.**
- ○ I had no idea when Unit 3 was going to explode but it was my turn to go to the MCR. **I was prepared to die and I told my father in my hometown to watch over my wife and daughter if something happened to me.**
- ○ I opened and closed the S/C spray valve and intake valve, and opened the D/W spray valves, but in addition to the fear of working in the dark with no scaffolding **I could also hear the sound of the SRV and feel it vibrating and thought to myself, “If steam leaks while I'm here I will die.”**
- ○ When I returned the MCR was in total darkness with only the HPCI, RCIC and DC power lamps lit. **It was surreal. I questioned whether it was really happening. It just didn't seem real.**
- ○ Radiation levels in the MCR started to rise by 0.01mSv every three seconds and we couldn’t leave,…**I thought this was the end.**
- ○ I knew I was going to be contaminated but **I had to remove my full face mask** in order to eat the hard biscuits and drink mineral water that had been stored for emergencies.
- ○ **In order to continue living (operating and monitoring) I had to eat** and my body was a concern.
- ○ I saw an unbelievable sight from the window of the changing room. **The**

seawalls were falling like dominoes. The gantry crane had speared the SW pump and multiple cars were being washed away. I could hear the sound of car horns wailing relentlessly from below.

○ During the shaking a large amount of adrenaline was rushing through my body and I wasn't really scared, but rather strangely calm. It was like being in a dream. I was in this state at least until I evacuated to Fukushima Daini.

○ As the shaking became more and more violent, I could see in front of me the ANN window glow red as Unit 6 scrammed and as I turned to Unit 5 and expected "it's probably also coming to Unit 5", several seconds later the Unit 5 scrammed as well. **Many fire alarms were set off because of the dust and the MCR was covered by a white cloud.** My nose became stuffed up and I wanted to put on a mask.

○ As I was checking parameters **I heard a huge bang.** The expressions on everyone's faces turned to one of bewilderment, and then after a little while all the **Unit 5 D/G tripped. The Unit 5 MCR was lit only by incandescent emergency lights.**

○ **I saw one of the heavy fuel oil tanks being washed toward the unloading wharf.** Just previously I'd seen a black ship of some sort narrowly avoid the tsunami and escape from the wharf. I had heard from a guardsman at another post that the workers had escaped without injury.

○ The power station I had been so accustomed to seeing underwent a complete change. Not just the reactor buildings that exploded, but **everywhere I could see had suffered damage and a copious amount of debris had been scattered about**. Also, heavy fuel oil tanks had been washed up to the site which is 10m above sea level and were blocking roads, and tons of cars and been turned over. The night was dark and eerily silent.

○ The first thing I thought was that **the site look like it had been bombed.** Perhaps it was because I was looking at everything through a full face mask but **it didn't seem real, it looked like I was watching the TV news or a movie.** I couldn't accept that this is the same power station that only a few days ago I was walking about freely breathing fresh air.

[Firsthand accounts of restoration work (venting)]

○ We asked for volunteers to engage in venting work. **A relatively young operator raised his hand and my eyes welled up with tears.** The shift supervisor assigned roles to each member. **Since workers would have to**

go in full protective gear without knowing how high radiation levels were, we did not let young operators go.

- ○ Three teams were prepared **in consideration of having to turn back because of radiation levels, stamina, and aftershocks. If all teams left together there would be no one left to come rescue them if something happened** so teams were instructed to go one by one.
- ○ As shift supervisor I wanted to go into the field myself and said so, but **a colleague said to me to "stay here in command until the end!" I bowed my head. I was speechless. I couldn't help but feel guilty.**
- ○ **If we all left at once there'd be no way of communicating so each team left one at a time.** We entered the building through the double doors on the south side. There was a dense fog and I wondered why there was fog at all. The inside of the building is usually dry. From the south side we went behind the HCU (hydraulic control unit) and went into the middle basement from the northwest stairs. We were checking radiation levels with dosimeters, but the instant we entered the torus room I knew we were in trouble and we ran back.
- ○ We had a 15 min. timeframe, so we grabbed flashlights and GM survey meters (for measuring radiation) and left them MCR. **I was trying to control my breathing in order to conserve oxygen, but I was concerned about radiation levels so as soon as I entered the Unit 1 building, I naturally began to jog. I stood in front of the double doors of the R/B and collected my nerves saying, "OK, let's do this"**.
- ○ When I arrived in front of the northwest entrance to the torus room, my survey meter was already indicating about 600 (units: mSv). The northwest entry into the torus room was closed and **I didn't know what conditions were like on the other side of the door. I knew that since I had come this far I would have to go all the way, so I grabbed the doorknob and entered the torus room.** I could see the stairs leading to the catwalk by the light of my flashlight. I glanced at my survey meter which was indicating between 900~1000 (maximum value) (units: mSv). **I told myself to push on until the needle went off the scale and proceeded to go left down the catwalk**.
- ○ When I reached the north side torus hatch (90°) t**he survey meter needle had already gone off the scale and wasn't budging. I knew I was only halfway down the catwalk and without knowing how high radiation levels were I deemed the situation to be dangerous, abandoned my**

mission and turned back. Since we couldn't hear each other **I made hand gestures to tell the team that we were retreating.** We ran back the same way we came this time faster and being careful not to trip.

- ○ The restoration team had gone to install a jig in the PCV venting valve to keep it open, but they returned to the MCR without performing this task because t**hey could hear steam rushing from the SRV (safety relief valve) to the S/C (suppression chamber) and feel heat, which prevented them from entering the torus.**
- ○ **In the darkness I could hear the SRV bubbling and on top of the S/C the soles of my boots melted.**
- ○ When I went to the S/C after being told to check if the XXX valve was open, my shoes melted. I could not see the valve because it was at the very top. **When I put my foot on the torus to check the temperature my sole melted instantly.** I decided I shouldn't proceed.

[Firsthand accounts of restoration work (S/C spray)]

- ○ My task in the field was opening the cooling water injection XX valve and the opening and closing of the S/C spray valve at 5:08 on March 13th. **It was when I turned off the S/P spray at the D/W spray that my boots melted. The S/C valve was too hot to grasp.**
- ○ The SRV started up when I operated the spray valve. **I heard a noise and the catwalk vibrated;** I yelled "Run!" without thinking and quickly evacuated out of the torus room. I operated the valves thinking to myself that **I would die if steam leaked.**
- ○ Inside the R/B I heard the sound of the SRV working. **In the torus room it was quite hot and I immediately started sweating**. I could see the torus shaking when the SRV was in operation. **I thought to myself that I would not make it back without injury if steam started to leak.**
- ○ I put my foot on the railing and tried to turn the valve key, but it was **too tight and took much energy to open. I was out of breath after only turning it twice and we took turns multiple times.** I thought to myself, "We need spray in order to suppress D/W and S/C pressure increases! We don't know how much of an effect the fire pump will have, but it's our only option at this time. **Someone has to do this!**"

[Firsthand accounts (cooling water injection, SRV/instrument restoration,

power restoration)]

(Water injection)

○ Contract employees were told by their president to return but **they saw how desperate we were working to save the power station and they started to cry and said, "We're not going anywhere".** They told the president that they would "return after a little while".

(SRV, instrument restoration)

○ Cutting SRV cable (processing cable to connect to batteries needed to open the SRV) is a tough job. Without wire strippers we had to process long lengths of wires (exposed cores) with pliers while being careful not to damage the cables. It was hard work to wire 10 batteries together in series. The MCR was dark and it was hard work. When using vinyl tape to connect the wires to the batteries the tape would stick to your gloves and make things difficult.

○ **When we connected enough batteries to get 120V DC they were all sparking…it was a scary sight. The batteries were sparking as we were connecting them. Even with 24V there was one time when my hand slipped and a large spark came out and melted the battery terminal**.

(Power restoration)

○ We couldn't enter the field due to aftershocks and tsunami alerts and in the seismic isolated building we weren't receiving any information from the shift in regard to power restoration, so we volunteered to the **TL (team leader) and chief engineers to inspect the T/B (turbine building) and S/B (service building).**

○ Manhole covers had been dislodged from the force of the water, so we walked through the debris by the light of the moon checking step by step to make sure there were no holes.

○ **Laying cable takes 1 to 2 months under ordinary conditions. Doing it in a couple of hours was unprecedented.** In the dark we had to locate the penetration seals and process the terminals. High voltage cable terminal processing is specialized work that needs to be done carefully. It usually takes 4 to 5 hours just to do that. And, we usually use machinery to lay the cable, but this time we did it by hand. The cables contain three cables about 15cm in diameter, so they are quite heavy.

○ Aftershocks caused the most trouble. We'd leave and have to come back, leave and come back. And, it took time to confirm safety in each instance. When there was a large aftershock we would rush back as if our life was in danger. So, we weren't ready to merely head back out after the quake ended and usually needed two hours or so to recover after which we headed back out.

○ **There was water in the electrical equipment room. I had to work in rubber boots. I assumed that no current was flowing, but it was scary because there was a possibility of lethal electrocution.**

○ It was like working next to the Grim Reaper. I had to work wearing a full face mask that I couldn't get used to, and then we would have to run every time there was an aftershock or tsunami. It was the same thing over and over again.

○ There is a water barrier by the P/C (power center: low-voltage power panel) and it was filled with water. **You couldn't get to the P/C without rubber boots and you couldn't put your tools on the floor. You needed someone to hold the flashlight and also your tools.**

○ **There were some people that came to work crying because they had lost their families in the earthquake,** and everyone at the power station didn't know whether their families were dead or alive because the phones weren't working.

[Conditions at time of explosions]

(At time of Unit 1 explosion)

○ **The windows of the fire engine were shattered by the force of the explosion and then all this debris came flying out.** I thought a hydrogen tank had leaked. I figured the whole area was full of gas**. Then everything looked blurry for an instant. Then there is a huge bang and everything flew into the air.** Then debris came flying from the front like rockets.

○ **All of a sudden without warning the entire MCR filled with a roar and shook vertically. The entire room was covered in a cloud of white dust.** Everyone put on masks with the command “Full face masks!”. There were people who even fell off their chairs.

○ **There was a huge sound, vertical shaking, and then the ceiling fell.** I thought it was an earthquake. The MCR contacted the seismic isolated building to find out what had happened. **The people in the seismic isolated building didn't know what had happened either so gave instructions to**

evacuate all young personnel to the seismic isolated building. Of shift members only chief engineers and higher remained. About 20 workers evacuated**. I led the way taking radiation level measurements while running to the evacuation area.** I left the S/B (service building) and evacuated through the gate in between Unit 2 and Unit 3. I could see the rebar of Unit 1. **My ICW (radiation measurement device) measured about 10mSv.**

○ In the midst of wondering how this is all going to turn out, **there was suddenly a huge bang and the ceiling panels fell off. The louvers of the ceilings got displaced and became suspended midair, and I instinctively thought, "The PCV has exploded" and then my thoughts turned to my own death.** Someone was holding a dosimeter and checked the readings, but there were no large fluctuations and everyone was like, "Radiation levels aren't rising?" "Maybe we're OK" "The MCR ceiling panels aren't made that robustly" "We should quickly close the emergency door and cover everything to prevent outside air from entering". We didn't know what had happened. The hotline with the seismic isolated building was still in place and we got word that it looked as if the R/B had exploded.

○ I was by the reverse valve pit on the Unit 1 side. The sheer force of the blast took me by surprise. **Looking to the sky I saw scattered debris fill the air and then start to fall. My partner and I ran for cover.** If we hadn't run we might've gotten hit with debris. The two of us ran away but there was so much debris falling that I pushed my partner towards the tank wall next to the turbine building which we stood next to trying to avoid debris. **After a little while we tried to run again but there was another worker next to a truck who couldn't stand, so we went back to help him and helped him walk out of there with us.** We yelled over the radio that there had been an explosion and walked back.

○ I was near the entrance to the seismic isolated building when Unit 1 exploded, but not being able to get inside, I ran confused. I wound up getting inside a fire engine that was close by.

○ **The seismic isolated building suddenly shook vertically.** I was at my desk in the seismic isolated building. There is a shutter that cuts across the ceiling of the seismic isolated building and **every time there was an aftershock it was possible that the shutter might fall, so I made sure not to be underneath it and was wary of above ever time there was shaking.**

The scariest time was when the building jumped vertically when Unit 1 exploded.

○ **I had returned to the seismic isolated building and was in front of it when the explosion occurred. We couldn't get inside of the seismic isolated building and everyone scattered and ran.** The automatic door had been bent. The automatic door was fixed after that and we were able to get inside.

○ I was at the entrance on the first floor. **I was blown back by the blast and the shockwave forced the inside doors of the seismic isolated building off the rails, thereby preventing the double doors from functioning.** So, I had someone bring me a crowbar and I levered the doors back on the rails so that it could open and close. There was a white substance falling from above at the time.

○ **The fire door had closed but the blast blew it open and then the ceiling dropped making it impossible to close.** I was on the second floor and **realized that the inside of the room would be contaminated so I took a pole and raised the ceiling in order to close the fire door.** The same thing happened on the first floor apparently. People nearby helped me.

(At the time of the Unit 3 explosion)

○ There was no wind pressure but we heard a sound like a balloon popping. **Then everything went white and after little bit I heard a sound like pitter patter and I thought that pieces of concrete were falling to the ground.** The arcade had been toppled by the tsunami but I tried to hide there. But I could still see the sky so I knew I was still in danger. **There was a pipe nearby that was exposed from above but I got next to it and took cover in its shadow. I thought I was going to die.** There was a bang and then everything turned white so I waited until I could see. I went in between Unit 2 and Unit 3 but there was a mountain of scattered debris. Vehicles were impassable so we all climbed over the scattered debris. The amount of debris between Units 2 and 3 was unbelievable.

○ After the Unit 1 hydrogen explosion we started laying cable again but then a hydrogen explosion occurred at Unit 3. The members of my team ran back to the emergency countermeasures office. The workers were in a panic.

○ I was in the Unit 3 Matsu corridor at the time of the Unit 3 explosion. **There was unbelievable explosion sound and we were engulfed in a white**

cloud of dust. The contractor's vehicle that we had come in was blown away so I was really scared.

- ○ I was in the truck bay of the Unit 2 turbine building. I was laying cable. **There was a large bang and the building shook. I thought it was an explosion.** I went outside the truck bay to check conditions and when I measured the smoke radiation **levels were high at about 50mSv, so I decided to evacuate after the smoke cleared.** I knew that I couldn't get through the gate on the Unit 1 side, so I evacuated through the gate between Unit 2 and Unit 3. **There was scattered debris from the explosion between Unit 2 and Unit 3 so I ran through trying to avoid** it. Some places had radiation levels reading about 100mSv. There were Self-Defense Force personnel and other people. I confirmed that everyone was able to evacuate.
- ○ When Unit 3 exploded I was in the Unit 3 and 4 MCR sampling data. **There was an incredible shock and I thought that the MCR was going to collapse and I would die.** I was overcome with intense fear. **Radiation levels were rising in the MCR so I found a low place and took refuge behind the Unit 4 MCR.** Members from the next shift were late, but just when I was about to be completely fed up with wearing the full face mask the next shift arrived. I was grateful and only wanted to quickly return to the seismic isolated building.
- ○ At around 11:00 when I was about to contact the head office by telephone and report after sampling data **there was an incredible blast. I couldn't see anything through the dust.** I was dazed for second and then confirmed the safety of my crew and reported to that office. They told me that Unit 3 had exploded. I figured that the next shift wouldn't arrive and **prepared myself to die from long-term exposure.** In the evening personnel from the next shift arrived, and I felt happy as well as guilty.

(When S/C pressure reached 0)

- ○ At around 0:00 I went into the MCR to get volunteers. I was sitting in front of control panels and also at the deputy shift supervisor’s desk. **Periodically I could hear bubbling sounds** and we were discussing what it was. **In the morning there was a bang** and I looked at the instrument behind me thinking it was the AM panel, but then **I heard that the S/C had dropped.** I reported to the shift supervisor that **there was a strange sound.**
- ○ This was different from the Unit 1 explosion. **There wasn't a shock like**

there was with Unit 1. It was like a large release. Didn't think it was the S/C. (i.e. I didn't think that the cause of the strange sound was the suppression chamber.) But data confirmed that S/C pressure had reached zero. It wasn't a very big sound. We could hear the sound in the MCR, but we didn't know what it was. There wasn't a lot of vibration.

(At the time of the Unit 4 explosion)

○ **When I entered the S/B I felt a shock from behind. I don't remember what it sounded like. It felt like wind pressure.** Then I went into the MCR and heard what had happened. All six of us got in a vehicle and tried to evacuate but there was a mountain of debris. We tried to go past the concentrated radwaste building but gradually became unable to pass. Then we saw Unit 4 explode. **Since we couldn't get through the debris in the vehicle we got out on the mountain side of the Unit 4 R/B and started running.** We had left the vehicle and couldn't run any further so we left through gate #7.

[Firsthand accounts from personnel in the offsite center]

○ Functions at the offsite center were restored in the early hours of March 12 and we got word that the offsite center was operable. **We had to wait in work clothes without coats for a long time under the cold winter sky. I was cold to the bone.**

○ **We immediately ran out of water, food, and daily commodities.** TEPCO employees went to buy supplies **but couldn't get anything even all the way at Iwaki City. They spent the whole day scrounging for supplies.**

○ After the Unit 1 explosion, workers that had undergone psychological trauma at the power station were evacuated temporarily to the offsite center. **Everyone's face was white, and no one spoke. There were people who were shaking and some women were crying.** I knew that they had done their best amidst a horrifying situation.

○ We were using the limited space between the double doors to change, survey and decontaminate. The radiation unit members from TEPCO performed their duties **non-stop. Only having water available for decontamination (normally hot water is used) made things difficult.** The number of workers increased and they were working on a hand-to-mouth basis, but **the same crew continued working diligently without additional**

support.

- ○ I was in a quandary about whether to move to the prefectural office or go back to the site. At this time a veteran operator in charge of Unit 5, 6 who had come with me to the offsite center said to me, "I will do anything. **I am prepared to throw myself into the jaws of the power station. If there's anything that needs to be done, just tell me. I want to show you that operators have guts if it's the last thing I do.**" (Note: With rising radiation levels it was decided that the offsite center be relocated to the prefectural office. This person would normally have moved to the prefectural office and worked in the offsite center, but he returned to the power station to engage in restoration work)

[Employees on vacation/not on-call]

- ○ The sun set and everything became dark, and with the blackout I couldn't do anything. **Without the time to check on the wellbeing of my daughter who was out, I charged my wife with the duty and headed by foot to the office at around 18:00.** Route 6 was quite congested with a long line of cars in line to get gasoline from the gas station. There was no one else walking on the road and I, without any information, just kept walking silently alone.
- ○ I had finished my first night shift and was resting in the dorm for unmarried workers when the earthquake occurred. Several minutes after the earthquake the tsunami alarm at the town office sounded and there was an announcement to evacuate away from the national road to the mountain side. **I temporarily evacuated to Futaba Hospital along with junior workers and other people from the dorm. The junior worker had developed a high fever so I left him at the hospital and started searching for an accessible road in my own car to get to the office since I was already scheduled for the night shift anyway, and assumed that the 18:00 night shift bus would not be coming.**
- ○ **The first floor of the Kita elementary school was filled with evacuees and I was in standby in a room on the second floor with about 10 other people from my neighborhood.** It was cold so I went to my house and brought about five blankets to give to the elderly. My house was totally dark so I'm glad I had brought a flashlight. After things calmed down a bit I heard about Article 10 or 15 notifications. I had evacuated with a colleague and we decided that things must be pretty bad, and decided to go to the office. **My**

wife was at the hospital busy caring for injured parties, and I couldn't get in touch with her but I was able to get through once and I told her that the family was safe and that I was going to the office.

- ○ I was sleeping at home after working the night shift when the earthquake occurred. I stepped outside to hear disaster warnings from the town office and an announcement for the fire brigade to convene immediately. **I was a volunteer fireman so I immediately headed to the town office. We used the fire engine to check the conditions of roads and reported back to the town office.** We were broadcasting a tsunami alert using the fire engine and upon returning to the town office we learned that the first tsunami wave had arrived, so we immediately rushed to the seashore but couldn't get close. **Thereafter we guided evacuees to the general sports center, checked for fires at apartments and houses, inspected places where gas tanks and water pipes had burst, and closed valves. Thereafter at around 19:30 a colleague and I were dropped off at the main gate of the power station by a fire brigade member in a fire station automobile.**
- ○ **I left my house at around 15:30 and checked on the status of evacuation of the neighborhood at the Futaba junior high school sports field. People in my house had already evacuated. I told the neighbor that I was going to the office and left.** I stopped by the dorm for unmarried workers on the way and headed on foot with four other employees to the power station. We arrived at the MCR at around 18:30.
- ○ After spending about one or two hours at the evacuation center I decided to go help out at the office so I told a colleague my intentions, returned to my apartment and headed to the office in my car. Upon arriving on site I was finally able to get through to my parents' house. **Upon telling my parents that I was going to help out with the accident at power station my father, who had worked at the power station, told me to "take care". I think at this point I had already accepted my possible fate.**
- ○ Early in the morning on March 12th town office employees were making announcements that the situation at the power station was dire, to use Route 288 to head towards Koriyama into the mountains, that there would be a bus but not everyone would be able to fit, and to use your own vehicle to evacuate, so **I evacuated with my parents and my sister's family to a relative's house** in what was Miyakoji Village. Route 288 was very congested. Around noon my father said that he was returning to Okuma to

get his medicine so I went with him and headed towards the power station. Along the way the fire department had set up checkpoints but we were able to be allowed through. **My father grabbed his medicine and turned back and I took the car at my parents' house and left for the power station.**

○ **On the 12th we were told to evacuate so I started to do so but along the way I began to worry about the plant and got out of the car and started walking back.** I told my family I was going to help them shut the plant down and then come back. I walked back to my house, got in a car and headed towards the power station. When I arrived I was in disbelief at the scene and started wondering what was happening. Workers in a full face masks met me at the main gate and I started to wonder why they were wearing masks at all.

[Getting in touch with family]

○ **Around March 15th I was finally able to get in touch with my family** and they told me that they had seen on the news that with the exception of about 50 necessary workers everyone had evacuated to 2F, so they were quite surprised when I told them I was still at 1F. **On March 22nd I was able for the first time to leave the power station after the earthquake and headed towards my parents' house where my family had evacuated to.**

○ **Around noon on March 16th I was finally able to get in touch with my wife when evacuated to the Kawauchi Village evacuation center** and confirmed that she was able to make it safely to my parents' house in Ibaraki Prefecture.

○ **I was finally able to meet up with my family at the evacuation center on March 27th, 16 days after the disaster.**

○ Around March 17th I heard from someone that we could use wireless phones to connect to an outside line via headquarters, and I was finally able to check on the safety of the members' families (mobile phones were still not working at this point). Of course I called my house first and was finally able to get in touch with my family who had evacuated. **I heard my wife crying; she had thought that I had died in the explosion. She couldn't get in touch with me, so it was natural that she had thought so.**

End