[12] PCV Venting and Alternative Cooling Water Injection Preparation for Fukushima Daiichi Nuclear Power Station Unit 2

[Main Report 8.2(2) Response Status for Cooling Water Injection at Fukushima Daiichi Unit 2;
8.2(3) Response Status for PCV Venting at Fukushima Daiichi Unit 2]

At the Fukushima Daiichi NPS Unit 2, the RCIC continued to operate immediately after the disaster and the injection of cooling water continued.

In order to determine whether PCV venting and alternative injection, for which preparations were being made in the interim, were carried out quickly and appropriately, the following facts that are currently known have been compiled below.

[Facts found regarding Primary Containment Vessel Venting]

- On March 12 at around 1:30, the Prime Minister, The Minister of Economy, Trade, and Industry, and the Nuclear and Industrial Safety Agency were informed about the plan to vent the PCVs of Unit 1 and Unit 2, which they approved.

- On March 12 at 2:55, it was determined that the RCIC was working through confirmation of the RCIC discharge pressure inside the reactor building, so venting of the Unit 1 PCV was given priority and the parameters for Unit 2 were to be continually monitored.

- While all efforts were being put into venting the Unit 1 PCV and injecting cooling water into the reactor, at around 15:36 on the 12th, a hydrogen explosion occurred in the Unit 1 reactor building. A reactor injection line was reconfigured and reactor cooling water injection resumed at around 19:00.

- On March 12 at 17:30, cooling water continued to be injected into the Unit 2 reactor using RCIC and PCV pressure was stabilizing at approximately between 200 and 300 kPa[abs], but it was still predicted that PCV would need to be vented, so the Site superintendent (Director of the ERC at Power Station) gave the order to begin preparations for PCV venting of Unit 2.

- Furthermore when actual preparations to vent the PCV of Unit 1 began, the same preparations, such as checking accident management procedures, valve diagrams, and piping and instrumentation drawings, were underway for Unit 2.

- On March 13 at 8:10, in accordance with procedures, the PCV venting line’s motor operated valve was switched to manual operation and opened to 25%.

- On March 13 at 10:15, the Site superintendent gave the order to start venting the Unit 2 PCV. At 11:00, in order to open the air operated valve (AO valve) in the vent line from the S/C, the portable generator being used for temporary lighting in the MCR was used as a power source to forcibly excite and open the electromagnetic valve installed in the air pipe for the AO valve drive mechanism. By doing this, when the rupture disk ruptures under a certain amount of pressure, the pressure from the PCV would be released into the atmosphere, and the vent line would be completed (workers were waiting for the rupture disk to rupture).

- However, at this time the pressure of the PCV (427kPa[gage]) was not high enough to cause the rupture disk to rupture, so the valves that comprise the vent line for the PCV were left open, and PCV pressure continued to be monitored.

- On March 14 at 11:01, an explosion occurred in the Unit 3 reactor building, and all workers, except the operators in the MCR, ceased working and evacuated to the seismic isolated building. Restoration work was put on hold temporarily while worker safety was confirmed, the status of the field was ascertained, and a safety check was made. PCV pressure fell to approximately 450 kPa[abs] (approx. 350 kPa[gage]), much lower than that required to rupture the rupture disk, and stabilized.

- The AO valve (isolation valve) on the vent line from the S/C closed because the electromagnetic excitation circuit was dislodged as a result of the explosion in the Unit 3 reactor building. After the evacuation order following the Unit 3 explosion was lifted, procedures to open the AO valve were conducted from around 16:00 on March 14, however at approximately 16:20 it became impossible to open as a result of insufficient drive mechanism air from the temporary air compressor.

- Since PCV pressure was not dropping at around 18:35 on March 14, not only the AO valve (isolation valve) in the vent line from the S/C, but also the AO valve (bypass valve) installed in parallel in the vent line from the S/C was focused on during continual work to restore the PCV vent line. It was thought that the large vent valve (AO valve) from the S/C could not be opened due to insufficient air from the temporary air compressor, but it is presumed that it could not be opened due to solenoid valve nonconformity).

- On March 14 at around 21:00, the AO valve in the vent line from the S/C was opened, and the vent line, with the exception of the rupture disk, was complete (workers were waiting for the rupture disk to rupture).

- In regard to PCV pressure, normally D/W and S/C pressures are approximately same, but while the pressure on the D/W side continued to increase, S/C pressure was stable at approximately 300 to 400 kPa[abs] resulting in unequal pressure. Since the pressure on the S/C side was too low to rupture the rupture disk, and D/W pressure side pressure continued increase, and at around 23:35 on March 14 it was decided to implement venting by opening the AO valve (bypass valve) in the vent line from the D/W.

- At 00:02 on March 15, the AO valve (bypass valve) on the vent line from the D/W was opened, and it was thought that the vent line, with the exception of the rupture disk, was completed, however several minutes later it was discovered that the AO valve (bypass valve) in the vent line from the D/W was closed. As a result it was not possible to determine whether venting was successful (ruptured status of the rupture disk ruptured).

[Facts found for alternative injection]

- On March 11 at 15:39, the RCIC was manually started.

- At 16:36, reactor water level could not be confirmed and cooling water injection status was unclear, so it was determined in accordance with Clause 15.1 of the Act on Special Measures concerning Nuclear Emergency Preparedness that a "specific event" (core cooling system injection failure) had occurred.

- At 17:12, the Site superintendent (director of the ERC at the power station) gave the order to deliberate accident management alternative injection (the FP, the MUWC, the residual heat removal system (RHR)) and alternative reactor cooling water injection methods using a fire engine.

- It was decided that an alternative injection line would be configured via the RHR as a result of these deliberations. However, whereas this line can be configured from the MCR if there is power, in the absence of power operation from the MCR was impossible, so in the pitch darkness the valves for the RHR in the reactor building, and turbine building were manually opened and a system was configured to enable injection after depressurization of the reactor (0.69MPa).

- At 21:50, as a result of restored instrumentation, it was discovered that reactor water level was 3400mm (TAF+3400mm) above the top of active fuel.

- On March 12 at 14:55, the ERC at the power station received a report from the MCR that had conducted a field inspection and deemed that the RCIC was working; it then decided to continue monitoring parameters and the operational state of the RCIC.

- On March 13 at 12:05, the Site superintendent (director of the ERC at the power station) gave the order to begin preparations for injecting seawater into the reactor in expectation that the RCIC would shut down. An injection line system was configured using the Unit 3 backwash valve pit as a water source, and a hose from the fire engine was laid.

- On March 14 at 11:01, workers, except the operators in the MCR, ceased work and evacuated to the seismic isolated building after the Unit 3 reactor building explosion. The seawater injection line that had been completed was rendered unusable as the fire engine and hoses were damaged in the explosion.

- From 13:05, field conditions were inspected and it was decided that seawater would be taken directly from the shallow draft quay to inject into the reactor instead of from the Unit 3 backwash valve pit.

- Since reactor water level was dropping it was thought that the RCIC might not be functioning, so at 13:25 on March 14 the incident was labeled as the aforementioned event (reactor cooling function loss) pursuant to Clause 15 of the Act on Special Measures concerning Nuclear Emergency Preparedness. Preparations to inject seawater into the reactor continued and at 14:43 connection to the fire engine FP was completed.

- In order to inject cooling water using the fire engine it was necessary to depressurize the reactor by manually opening the main steam safety relief valve (SRV), but since the temperature and pressure of the S/C were high, it was possible that steam would not be condensed in the S/C making it difficult to depressurize, so it was decided by the ERC at the power station that the SRV would be manually opened, the reactor depressurized, and seawater injected after preparations to inject seawater into the reactor and vent the S/C were made.

- However, at around 16:20 on March 14, it was deemed that manually opening the vent valve would take time, so the Site superintendent prioritized depressurization of the reactor using the SRV and ordered that the S/C be vented simultaneously.

- At around 16:30, the fire engine was started and preparations were made to start injecting seawater during reactor depressurization. At 16:34, the reactor started to depressurize, and seawater started to be injected into the reactor from the FP line.

- The SRV did not open due to insufficient battery voltage and workers continued to attempt to open multiple SRVs.

- At around 18:00, depressurization of the reactor was started using the SRV, but the temperature and pressure of the S/C were high thereby preventing condensation, so it took time for the S/C to depressurize.

- High radiation levels in the field prevented field monitoring, such as confirming the operational state of the fire engine, and workers were forced to work in shifts. It was then discovered at 19:20 on March 14 that the fire engine, which had been on standby to inject seawater into the reactor, had stopped due to lack of fuel.

- At 19:54, injection of seawater into the reactor was started using a FP line from the fire engine (two fire engines were started, one at 19:54, and the other at 19:57) began.