[4] Concerned Issues and Improvement Measures of the Mark I Primary Containment Vessel

Since the Fukushima Daiichi NPS accident, some have been pointed out that the Mark I PCV had problems and this containment vessel was the cause of the accident. It is true that there have been issues in the past, but these issues have been dealt with in various ways. The facts related to these countermeasures are stated below.

[Facts found]

- PCV volume: It has been pointed out that the Mark I PCV is small and that if steam is leaked into the PCV due to incidents such as broken pipes, the pressure rises quickly, and a problem can occur easily.

  - BWR adapts PCV of pressure suppression type that suppresses pressure rises by forcing the steam (released into the vessel due to incidents such as broken pipes) through the water pool in the suppression chamber (S/C) [inside the PCV] and thereby condensing it, which itself is not an issue.
  - Both the Mark I and Mark II PCVs are the pressure suppression type and are designed to have a direct correlation between volume and output.
  - According to the volume-power ratio, as an appropriate index for comparing the relative sizes, the Mark I and Mark II vessels are almost the same, and hence, the Mark I is not particularly small.

Table: Primary containment vessel volume - reactor power ratio

Reactor	1F-1	1F-2~5	1F-6, 2F-1	2F-2~4	KK-6/7(reference)
Primary containment vessel	Mark I	Mark I	Mark II	Mark II advanced	RCCV
Volume-Power ratio *1, *2	Approx. 4.4	Approx. 3.1	Approx. 3.0	Approx. 4.3	Approx. 3.4

*1: Values are calculated as follows: primary containment vessel volume [m3]/reactor heat power [MWt].

*2: Reactor heat power values were taken from the application documents for the Establishing Permit. Primary containment vessel volume was taken from the sum of the volume of the dry well (D/W, including vent pipes) and the volume of S/C space as stated on the attachment 8 to the application documents for the Establishing Permit.

- Mark I PCV performance improvements (vents)

  - The US Nuclear Regulatory Agency (NRC) has stated that installing pressure hardened vents to the Mark I PCV is effective for reducing the risk of core damage. In Japan, probabilistic safety assessments were conducted to confirm the effectiveness of pressure hardened vents for preventing core damage and reducing impacts, and to examine the viability of actual installation, and such vents were installed on equipment including the Mark II PCV.

- Load on the S/C during an accident (a comment pointing out that the unexpected load would be placed when the steam from the reactor is quenched into the S/C for depressurization)

  - While the Mark III PCV was developed in the U.S, the load that is generated when the high pressure steam generated due to incidents such as broken pipes is quenched into the S/C became an issue, and therefore, the countermeasure was adopted (equipment that reduces the dynamic load from steam quenching: quencher direction, an installed device that disperses the steam equally in four directions instead of one.)
  - The same countermeasures were implemented in Japan based on the US countermeasures. The examination with respect to this load has been compiled in the guideline issued by the Nuclear Safety Commission of Japan, “Evaluation Guidelines for Dynamic Load on the BWR. Mark I PCV’s Suppression System” (the guideline for Mark II that is equivalent to this guideline has also been compiled).

- Measures to prevent hydrogen explosions inside the PCV during an accident (a comment pointing out that the size of the Mark I PCV is small, and therefore, the concentration level causing the hydrogen explosion can be easily achieved inside the PCV)

  - The measures have been taken to prevent combustion and explosions inside the PCV, even in the event that a large amount of hydrogen is generated, by injecting Nitrogen into the PCV and thereby controlling the oxygen concentration below a certain level.
  - The Flammability Control System (FCS), which is designed to heat up and recombine hydrogen and oxygen to suppress concentration levels in the PCV after an accident, is installed in the reactor building.