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Effect on the Integrity of the DN300 Pipe and Valves in the Cooling Water System Imposed by the Pipes and Ventilation Pipes above in an Earthquake Situation

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Abstract : Presently, more and more nuclear power plants are facing the issue of life extension. When a nuclear power plant applies for an extension of life, its condition needs to meet the current design standards, which is not fine for all old reactors, typically for seismic design. Seismic-grade equipment in nuclear power plants are now generally placed separately from the non-seismic-grade equipment, but it was not strictly required before. Therefore, it is very important to study whether non-seismic-grade equipment will affect the seismic-grade equipment when dropped down in an earthquake situation, which is related to the safety of nuclear power plants and future life extension applications. This research was based on the cooling water system with the seismic and non-seismic grade equipment installed together, as an example to study whether the non-seismic-grade equipment such as DN50 fire pipes and ventilation pipes arranged above will damage the DN300 pipes and valves arranged below when earthquakes occur. In the study, the simulation was carried out by ANSYS / LY-DYNA, and Johnson-Cook was used as the material model and failure model. For the experiments, the relative positions of objects in the room were restored by 1: 1. In the experiment, the pipes and valves were filled with water with a pressure of 0.785 MPa. The pressure-holding performance of the pipe was used as a criterion for damage. In addition to the pressure-holding performance, the opening torque was considered as well for the valves. The research results show that when the 10-meter-long DN50 pipe was dropped from the position of 8 meters height and the 8-meter-long air pipe dropped from a position of 3.6 meters height, they do not affect the integrity of DN300 pipe below. There is no failure phenomenon in the simulation as well. After the experiment, the pressure drop in two hours for the pipe is less than 0.1%. The main body of the valve does not fail either. The opening torque change after the experiment is less than 0.5%, but the handwheel of the valve may break, which affects the opening actions. In summary, impacts of the upper pipes and ventilation pipes dropdown on the integrity of the DN300 pipes and valves below in a cooling water system of a typical second-generation nuclear power plant under an earthquake was studied. As a result, the functionality of the DN300 pipeline and the valves themselves are not significantly affected, but the handwheel of the valve or similar articles can probably be broken and need to take care.

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