Assessment of Core Status of TEPCO's Fukushima Daiichi Nuclear Power Plants (88)Suppression Pool thermal-hydraulics analysis of Fukushima Daichii Unit-2 using POOL-3D module of the SAMPSON code

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Until now the PCV pressurization has been not reproduced using a deterministic model but only using parameter models and therefore introducing some uncertainties. This problem raises from the single node discretization used for the suppression pool, then a different S/C module, called POOL-3D, has been introduced in the SAMPSON code and the pool has been modeled using a multi-node finite volume approach. In this work, the first 70 hours after the earthquake were simulated focusing on the S/C pool thermal-hydraulics parameters. Introducing a deterministic model the PCV behavior has been reproduced with different torus room flooding and it was found that thermal stratification plays a key role in the PCV pressurization.

Keywords: Thermal-Hydraulics, Suppression Chamber, Thermal Stratification, Several Accident, SAMPSON

1. Introduction

The suppression pool is an important part of a BWR reactor containment safety design. Its main function is to prevent overpressure inside the Primary Containment Vessel (PCV) during Loss of Coolant Accident (LOCA) or during Safety Relief Valve (SRV) activation. The steam generated in the reactor vessel is vented through the blowdown pipes (LOCA) or spargers (SRV) or downcomer (RCIC) condenses in the pressure suppression water pool and consequently the pool temperature increases leading to a pressure raising. Thermal stratification can appear [1] causing a loss in pool suppression efficiency because the pool temperature in some spot is close to the saturation temperature and therefore the steam condensation stops. In the past the PCV behavior has been reproduced with SAMPSON SA [3] using some empirical correlations, but at the same time those correlations introduced a lot of uncertainties. A lumped parameters model is not able to reproduce the thermal stratification and its effects in a deterministic way, therefore a new approach to describe the suppression pool. This new approach is realized introducing a three dimensional discretization of the S/C through POOL3D module that uses a multi-node finite volume approach. The S/C has been discretized using a detailed mesh in order to capture the thermal stratification generated by the steam injection and reproduce its effects on the PCV pressure.

2. Results and methodology

Starting from the PSI experiment [2] a correlation between the cell temperature and the saturation temperature has been introduced in order to evaluate the mass of condensed steam inside the pool. From the accident measurements none information are available regarding the flooding of the torus room, therefore different cases with different quantity of sea water being in the torus room have been performed. In Fig1 the PCV transient pressure is shown for the different cases and compared against the accidental measurements and an old version of SAMPSON SA. Starting from the case without flooding (orange line) to the case with highest flooding the results are quite different. Nonetheless the red line and the purple line show a good agreement with the measurements and they capture well the pressure increasing during the first 70 hours of the accident.

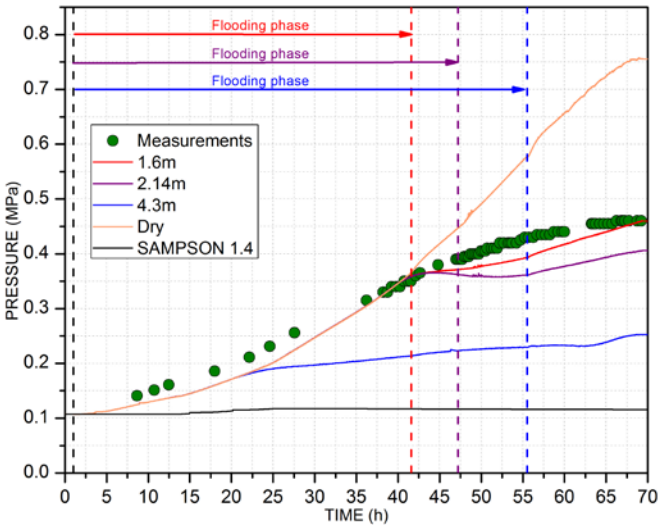

Fig1: PCV pressure transient for different water level in the

3. Conclusion

The new module POOL3D captures well the pressure increasing, the red line in Fig1 is the simulation that better reproduces the measurements. From this first analysis is possible to understand how the boundary conditions affect the results since the water mass surrounding the suppression chamber mitigates the thermal stratification inside the pool and therefore the pressure in the PCV.

References

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