東京電力福島第一原子力発電所炉内状況把握の解析・評価
(92) SAMPSON/POOL3D による福島第一 2 号機解析

Assessment of Core Status of TEPCO's Fukushima Daiichi Nuclear Power Plants
(92) Fukushima Daiichi Unit 2 plant analysis using SAMPSON/POOL3D

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One of the main issue regards the Fukushima accident is the relatively fast pressure increase observed in the Primary Containment Vessel (PCV) of Unit-2 and Unit-3 that is difficult to be reproduced by the classic lumped parameter approach. Therefore a new three dimensional module, called POOL3D and coupled with the lumped parameter containment module, has been introduced into SAMPSON code in order to obtain a complete temperature distribution inside the S/P. The new module has been tested on Fukushima Unit-2 simulating the first 70 hours after SCRAM and a sensitivity analysis on the torus room flooding has been performed.

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

1. Introduction

In the Unit-2 a fast PCV pressure increasing has been observed. This behavior could be a consequence of the S/P thermal stratification caused by the prolonged RCIC operation. In the past the PCV behavior has been calculated with SAMPSON [1] 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 in order to capture the thermal stratification generated by the steam injection and reproduce its effects on the PCV pressure.

2. Results and methodology

POOL3D is able to provide a full 3D temperature distribution of the S/P. In addition two models representing the steam released from the pool to gas phase have been implemented. The first is a superficial evaporation model [2]. The second model implemented is a partial condensation model based on the PSI experiment [3]. From the accident measurements there is limited information available regarding the flooding of the torus room, therefore different cases with different quantity of sea water injected in the torus room have been performed. In Fig.1 the PCV transient pressure is shown for the different cases and compared against the accidental measurement. Starting from the case without flooding (green line) to the case with highest flooding (black line) the results are quite different.

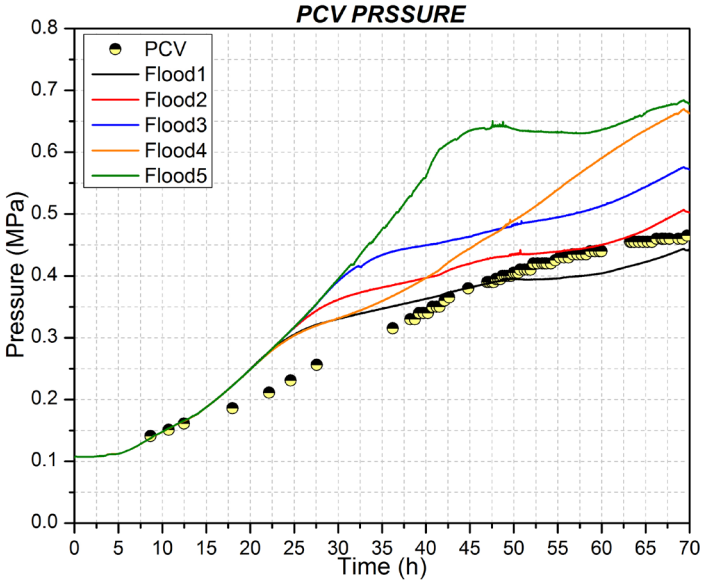

Fig.1: PCV pressure transient for different torus room flooding.

3. Conclusion

The new SAMPSON module POOL3D captures well the pressure increasing, the black and red lines in Fig.1 are the simulations that better reproduces the measurements. From this first analysis it 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.

－Acknowledgement－

This work has been financially supported by the Japanese government's Ministry of Economy, Trade, and Industry. Technical support from the project team is greatly appreciated.

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