論 文 の 内 容 の 要 旨

Thesis Summary

A Study on Heat Transfer inside Fukushima Daiichi Unit-1 Primary Containment Vessel Considering Evaporation and Condensation

（蒸発凝縮を考慮した福島第一原子力発電所内部の熱輸送に関する研究）

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Among the issues related to decommissioning of Fukushima Power Plants fuel debris retrieval has priority to be solved. In order to conduct fuel retrieval activities safely, information about debris location and its characteristics carry crucial importance.

The present work focused on retrieving more information about debris location and its characteristics to contribute the decommissioning activities in Fukushima Daiichi Unit-1 (1F1) Power Plant.

Despite several attempts, information collected up to now is insufficient to locate debris inside the containment. Such information can be extracted by evaluating gas flow inside primary containment vessel (PCV) considering the measurements taken after the accident. In this study a commercial software STAR-CCM+, was used to conduct simulations and particular attention is given to model gas flow and related heat transfer phenomena inside the PCV.

After post processing the available measurement data published by TEPCO, steady cooling period of debris selected as an analysis date considering availability and stability of data. Steady state CFD analysis are conducted assuming that during this period, decay heat plays a role as a heat source and PCV walls are the ultimate heat sink. Results of the simulations estimated the amount of decay heat dissipated to superheat gas and address the temperature asymmetry on safety valves by introducing additional heat source to represent local heating. Moreover,

possibility to predict debris spreading through the opening of the pedestal is also evaluated by altering heat source amount inside pedestal and on the drywell floor.

Noting that the simulations conduct with only convective heat transfer show excessive cooling on top head region of PCV, several condensation modelling is taken into account to simulate wall condensation in 1F1 PCV. Finally a model based on diffusion theory is proposed to evaluate wall condensation. Proposed model initially applied to simulate condensation in the COPAIN facility via implementing user defined functions into STAR-CCM+ to validate the results from the model with experimental data. Furthermore, discussion about the effect of nitrogen injection on debris cooling is introduced.

In last chapter, concluding remarks are drawn and future activities are suggested.