METHODOLOGY USING MELCOR2.1/SNAP TO ESTABLISH AN SBO MODEL OF CHINSHAN BWR/4 NUCLEAR POWER PLANT

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ABSTRACT

After Fukushima Daiichi accident, the safety analysis of severe accident became one of the safety concerns in Taiwan. In recent days, both MELCOR and MAAP were the main used codes for nuclear reactor severe accident in Taiwan. These two codes can both calculate the phenomenon happen in the late reactor severe accident, like core meltdown, hydrogen generation and fuel debris penetrations, etc.

The main MELCOR used in Taiwan now was an earlier version and in the ASCII code mode (Coding with text file) which is not always easily to be understood by a beginner of the code. In this research, the latest version MELCOR2.1 was used and combined with Symbolic Nuclear Analysis Package (SNAP). In this combination, MELCOR was used with a graphical user interface (GUI) that users can easily modify any detail of the model. It can also combine some other applications like AptPlot for output drawing and DAKOTA for uncertainty analysis. There were three main steps in this research. First one is to establish the MELCOR2.1/SNAP model of Chinshan (BWR/4) nuclear power plant (NPP). This model included 22 control volumes of lower plenum, core, separator, dryer, drywell, wetwell, reactor building and environment, etc. The components of Fuel Dispersal, Cavities and Radionuclide were also built in. Second, a steady-state test was calculated by MELCOR to check the model. After the steady state calculations, the model of MELCOR2.1/SNAP will next used for a transient situation. Finally, the Chinshan NPP model was set to a situation of SBO to simplify the control system. After the model was built, the SBO calculation of this model was done and compared to the results of MAAP5.0 and MELCOR1.8.5. The results of this MELCOR2.1/SNAP model fit the MAAP results well at the main outputs we concerns in the severe accident. In addition, a Chinshan NPP spent fuel pool SBO model was also built by MELCOR2.1/SNAP and the output of cladding temperatures, water level also fit the results from MAAP calculations. The comparisons of MELCOR spent fuel pool and some other thermal-hydraulic codes like TRACE and CFD were also done in this research.

KEYWORDS
MELCOR 2.1, SNAP, severe accident, SBO, spent fuel pool

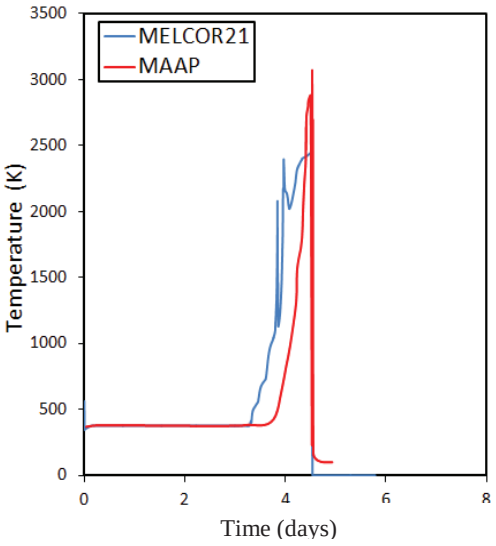

Figure 21. Peak cladding temperature of spent fuel pool

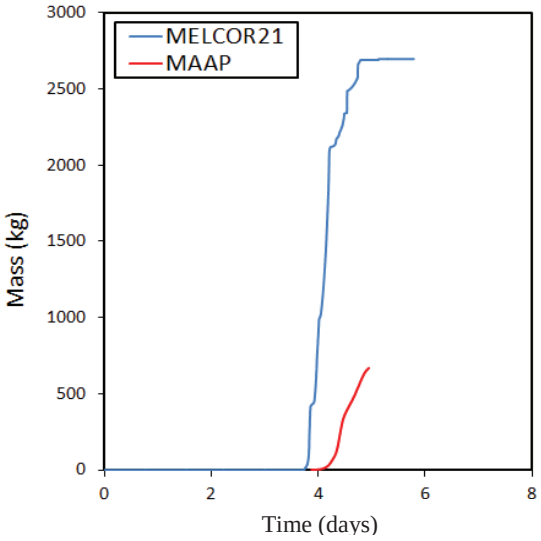

Figure 22. Hydrogen generation

4. CONCLUSIONS

By the calculation of MELCOR2.1/SNAP, this study gives several conclusions:

1. This study has developed the MELCOR2.1/SNAP models of the Chinshan NPP successfully.
2. By using the above models, the safety analysis of the Chinshan NPP SBO severe accident was performed under the condition that all water injection system failed. The analysis results of MELCOR2.1, MELCOR1.8.5, MAAP5.0, are similar in this case. It indicates that the MELCOR2.1 results are consistent with other codes/versions.
3. The analysis results depicted that the uncovered of the fuels occurred in 42 minutes and the fuel debris drop to lower plenum at 2.35 hrs.
4. According to this study, the case of SBO caused the RPV fail at 6.83 hrs. and the reactor building fail at 6.86 hrs.
5. MELCOR2.1/SNAP can predict the water level and cladding temperature well in a spent fuel pool SBO case.
6. This study's results can help to evaluate the safety issue of the Chinshan NPP severe accident.

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