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# Development of the Ulchin 34 Melcor1.8.6 Model for Phenomenological Uncertainty analysis in Level 2 PSA

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## 1. Introduction

Probabilistic Safety Assessment (PSA) technology has been widely used to measure safety levels and identify weak points of nuclear power plants. Since the Reactor Safety Study (WASH-1400), event tree method has been used. In level 2 PSA, mainly three kinds of considerations are included: phenomenological events, operator actions, and heat removal system operations.

It was pointed out that a structuring CET with phenomenological events was difficult and there were large uncertainties due to a lack of data used in an expert judgement and an expert judgement itself. PSA has been playing important roles to identify the weak point of NPPs and derive research topics. However, PSA results themselves, like containment failure probability, have no significant physical meaning.

In order to use PSA results to design and improve NPPs and apply to decision making in NPPs, the quality of PSA results should be improved and uncertainties lied in PSA methodologies should be eliminated.

Various researches to improve the quality of PSAs are ongoing. Phenomenological uncertainty analysis to reduce level 2 PSA uncertainties using the MELCOR code is off the ground. First of all, MELCOR1.8.6 model for the phenomenological uncertainty analysis has been developed [1].

## 2. Methods and Results

In this section MELCOR1.8.6 model development strategy, development results, and verification are described.

### *2.1 Model Development Strategy*

Existing MELCOR1.8.6 model for the OPR1000 developed by KAERI was modified in accordance with Ulchin 34 nuclear power plant [2]. And some safety features were developed and modified through the design data survey and investigation. Also, for the natural circulation flow simulation, the reactor vessel and RCS nodalization was departmentalized.

### *2.2 Model Development Results*

Departmentalized reactor vessel and RCS nodalization are shown in below figure 1. For natural circulation flow simulation, reactor vessel was divided into 67 control volumes and hot leg, cold leg, and steam generator were departmentalized.

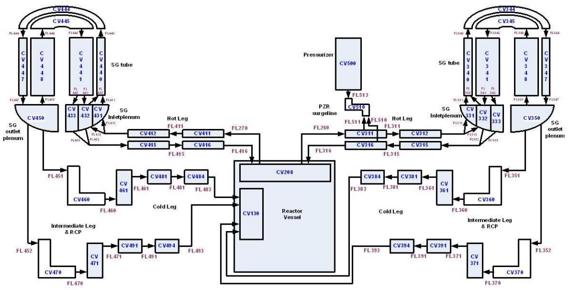

Fig. 1. The Ulchin 34 RCS Nodalization for the MELCOR1.8.6 Model Development.

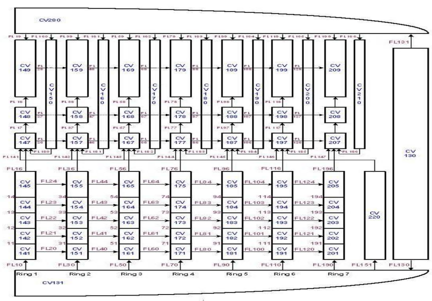

Fig. 2. The Ulchin 34 Core Nodalization for the MELCOR1.8.6 Model Development.

High pressure safety injection system (HPSI), low pressure safety injection system (LPSI), safety injection tank (SIT), auxiliary feedwater system (AFWS), pressurizer safety valves (PSV), containment spray system (CSS), containment and cavity(CMT), and main steam system(MSS) was developed and modified in accordance with design data. Control functions about system operation and trip was developed and applied to MELCOR1.8.6 model. An example of control function logic diagram is shown in below figure 3.

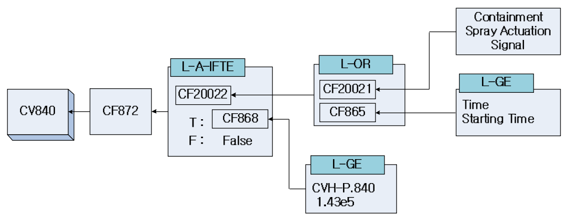


Fig. 3. Control Function Logic Diagram of Containment Spray System.

### *2.3 Model Verification*

For a developed MELCOR1.8.6 model verification, comparisons between developed model results and PSA level 2 report results which were calculated by MAAP4 has been accomplished [3].

Representative severe accident scenarios applied to comparison studies are the station blackout (SBO-PDS_S607) for a high pressure accident and the small loss of coolant accident (SLOCA-PDS_S179) for a low pressure accident.

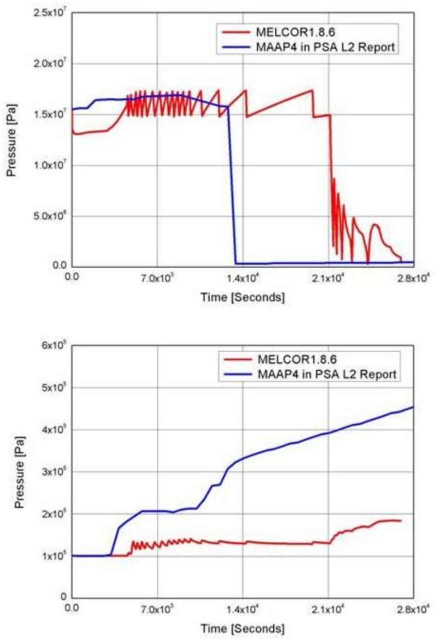


Fig. 4. Comparison Results of RCS Pressure and Containment Pressure for the SBO Scenario.

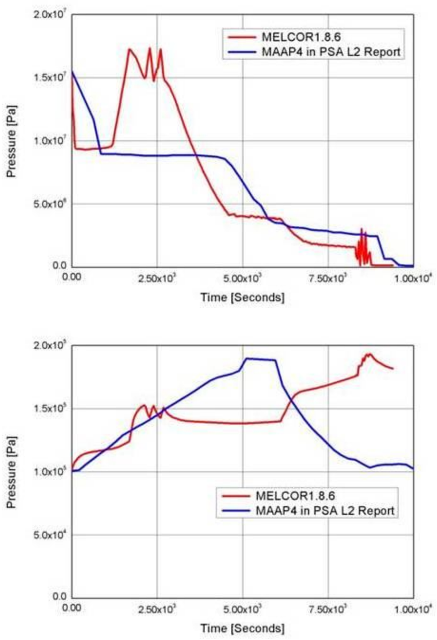


Fig. 5. Comparison Results of RCS Pressure and Containment Pressure for the SLOCA Scenario.

After the SBO occurs, natural circulation flow is expected to take place. As a result, the RCS depressurization timing by the RCS failure of the MELCOR1.8.6 model result is later than the MAAP result which the natural circulation flow is not taken place.

In MELCOR1.8.6 model calculation for the SLOCA, the RCS pressure rise by steam generator dry out. After then, as pressurizer safety valves open, the RCS pressure goes down, which is agreed with the MAAP result.

## 3. Conclusions

The Ulchin 34 MELCOR model development results are shown above. And the developed model simulates severe accident phenomena in U34 NPP closely. By the Ulchin 34 MELCOR1.8.6 model development, a foundation is formed for phenomenological uncertainty analysis in level 2 PSA. Accordingly, the developed MELCOR1.8.6 model will contribute to improve the PSA quality by using phenomenological uncertainty analysis hereafter.

## REFERENCES

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