Transactions of the Korean Nuclear Society Autumn Meeting
Gyeongju, Korea, October 24-25, 2013

The Simulation of Fukushima Unit-2 Accident with MELCOR 1.8.6 based on the plant data being provided from BSAF program

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1. Abstract

This paper shows the calculation results on the severe accident of the Fukushima Daiichi unit-2 that had been occurred on March in 2011 in Japan. The simulation has performed with MELCOR version 1.8.6 YV and used the real plant data being provided under the BSAF project [1]. The calculation scope was covered from the time of the reactor trip to the end of transient when the top of core covered with the sea water being injected by the fire pump. The results on the source term are not included.

The previous study showed the large differences on the pressure behaviors for the reactor vessel and the dry-well against the measured data [2]. In this study, two phenomena that might happen during the accident were considered to solve the above mentioned problems. These phenomena are the carry-over of two-phase fluid to the main steam line (MSL) and the flooding of the outer surface of torus with sea water by the tsunamis.

The calculation with considering these two phenomena showed the similar trends of the pressure behaviors for both the reactor vessel and the dry-well, respectively.

2. Introduction

2.1 Fukushima-2 Accident and BSAF program

In 2012 spring, BSAF project was organized to share the information and experience in modeling the severe accident phenomena related to the Fukushima accident among other countries. And also the international bench marking analysis was started to prepare the data base on the status of core for the decommissioning project under the BSAF project.

In the frame of the BSAF project, the accident analysis of the Fukushima Daiichi unit-2 was performed with MELCOR 1.8.6 by KAERI. In this study, the simulation results on the pressure changes for the reactor vessel and the dry-well were compared against the measured data and the results from the previous study.

3. Works

3.1 Nodalization & Accident Modeling

The input modeling was focused on the improvement of the disagreements from the previous study for the pressure behaviors in both of the dry-well and the reactor vessel against the measurement. The given boundary conditions are the RCIC operation data, the sea water injection data by the fire pump to the main feed line. Figure 3.1 shows the nodal picture of the Fukushima Daiichi unit-2 plant.

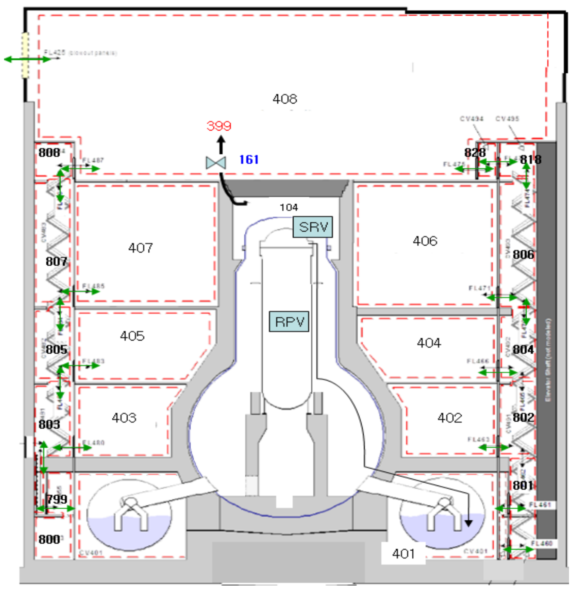

Figure 3.1 Nodal-picture for the Fukushima Daiichi unit-2 plant.

For the pressure of reactor vessel, it modeled that the two phase fluid including a steam flows out to the MSL and into the wet-well through the RCIC turbine loop after the reactor trips. It assumed that the enthalpy of the fluid being injected to the wet-well including a steam depends on the 'steam table'. The 'steam table' consists of the enthalpy values for both the saturated water and the saturated steam according to the varying system pressure. We neglected the efficiency of the degraded RCIC turbine but the fractions of both the mass and the enthalpy for the steam and the water were determined by user.

The final steam extraction rate from the 'steam dome' was derived by many tuning works. Also, the carry-over of the hot water from the steam dome to MSL was modeled based on the user defined minimum level, which is the bottom level of MSL pipe.

For the dry-well pressure, the partial flooding of the outer surface of torus (3~5% based on the height of torus) by the tsunamis was modeled.

3.2 Calculation Results

The previous study showed that the predicted pressure behaviors for the reactor vessel remained at the SRV's set points. But the measured data showed that it remained at far below the SRV's set points. Figure 3.2 showed that the consideration of the carry-over of two-phase fluid through the MSL made a good prediction for the pressure behaviors of reactor vessel.

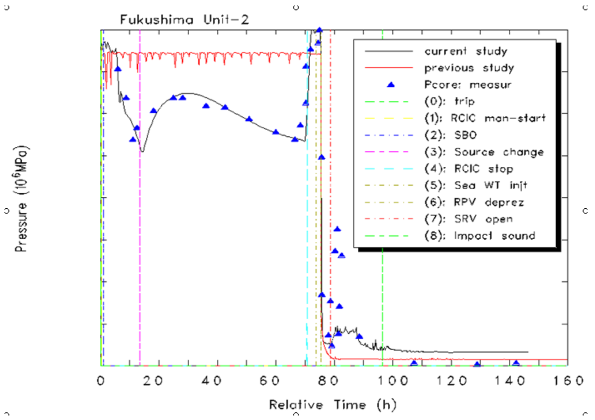

Figure 3.2 Pressure Change in Reactor vessel

Figure 3.3 shows the pressure behaviors for the dry-well. The previous study that did not consider the partial flooding of the outer surface of torus showed that the dry-well pressure continued to increase until the wet-well pressure reaches the failure point of around 11 bars.

However, the consideration of partial flooding of the outer surface of torus showed well prediction of the dry-well pressure. It implies that the partial flooding in the torus room might be occurred.

After the time of 'RCIC stop', the measured dry-well pressure showed a decrease of the pressure. It is because that there was no energy input for the wet-well. During the forced depressurization of reactor vessel, all the discharged steam was injected into the wet-well.

However, from this moment, the pressure increase in the dry-well was dominated by the pressure spikes being occurred from the reactor vessel by injecting the sea water.

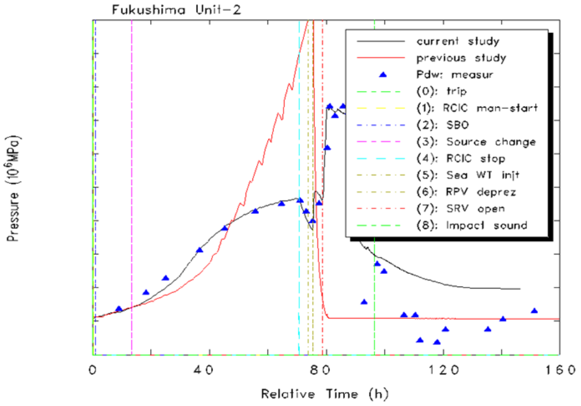

Figure 3.2 Dry-well pressure changes

4. Conclusion

The simulation of the severe accident on Fukushima Daiichi unit-2 was performed by MELCOR 1.8.6 with the geometrical data for real plant and the boundary conditions for the accident being provided from the 'BSAF project'.

The two phenomena such as the carry-over of two-phase fluid to MSL and the partial flooding of torus were modeled to improve the disagreement from the previous study against the measurement.

The modeling of these two phenomena made the good predictions for the pressure behaviors in both of the dry-well and the reactor vessel against the measurement.

ACKNOWLEDGEMENTS

Authors would like to thank MEST for supporting this research with the frame of MEST long term R&D program.

REFERENCES

[1] "OECD/NEA BSAF boundary conditions", IAE, November, 07, 2012, Tokyo, Hamamatsucho, Japan.

[2] Jong-Hwa Park, Seong-Wan Hong, Jin-Ho Song. "The simulation of Fukushima Unit-2 Accident with MELCOR based on the boundary conditions from TEPCO", KNS autumn meeting, Oct, 25~26, 2012, Gyeongju, Korea.