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SKN 3&4 SBO Simulation with PCTRAN APR1400

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1. Introduction

PCTRAN (Personal Computer Transient Analyzer) is the first PC-based nuclear power plant simulator developed by Micro-Simulation Technology. It is used by NRC, IAEA, many government agencies and nuclear power plants all over the world. PCTRAN has several modules corresponding to each reactor type including APR1400. RadPuff is an atmospheric dispersion module which can process the dose release generated by PCTRAN calculation.

After Fukushima Daiichi Nuclear Accident, it was shown that every power supply can be cut off by natural disaster such as tsunami, and thus simultaneous accidents at multiple units have been key issue. Prior to simulation of the accident at multiple units, SBO (Station Blackout) at a single unit of SKN 3&4 was simulated in advance. The operational parameters were calculated, and dose assessment was also performed with the result of the simulation.

2. Simulation of SBO

2.1. Scenario

Every on-site and off-site power supply is cut off by tsunami. Thus, all systems powered by AC power supply cannot be operated and only turbine driven pumps work normally.

In first 30 minutes, normal condition is maintained with Initial Condition #1 of PCTRAN APR1400. SBO occurs at 30 minutes by tsunami, and thus all motor driven systems are broken down. (Figure 1) It is assumed that 30 minutes are required to activate the turbine driven AFWP (Aux. Feedwater Pump) by operator. After one hour from the activation of the turbine driven pumps, they are shut down by controller failure. At that moment, LOCA (Loss of Coolant Accident) occurs at primary loop (hot leg) with area of 10 cm^2 simultaneously. (Figure 2) The scenario is terminated after six hours from the occurrence of LOCA. This scenario is tabulated in Table 1.

Table 1. Scenario of SBO Simulation

Time (sec)	Set-up
0	Normal operation with IC#1
1800	SBO occurs
3600	Activation of turbine driven pumps
5400	Shutdown of turbine driven pumps LOCA occurs at primary loop
27000	Termination of simulation

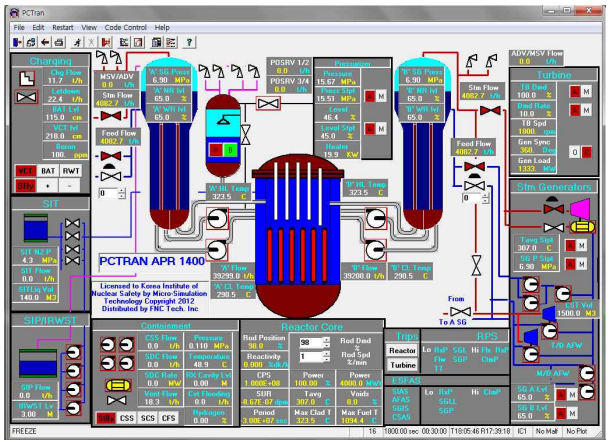

Fig. 1. Simulation of SBO

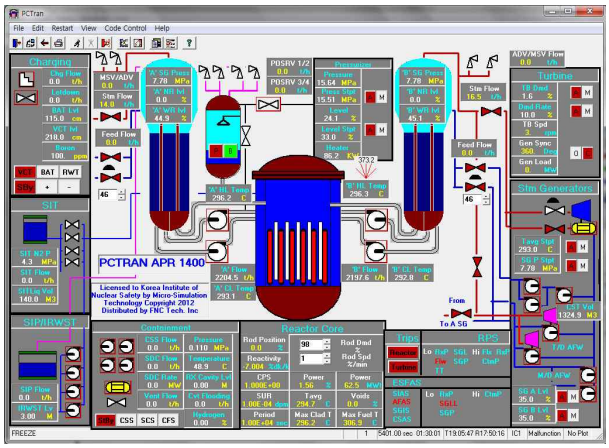

Fig. 2. Turbine driven pumps shutdown and occurrence of LOCA

2.2. Result of Simulation

From the SBO simulation with PCTRAN APR1400, changes of the operational parameters in nuclear power plant are obtained over time. There are many parameters such as pressure of reactor coolant system, average temperature of reactor coolant, pressure of steam generator and so on. Transitions of the average temperature of reactor coolant and the concentration of I-131 in reactor coolant are described in Figure 3, representatively.

2.3. Dose Assessment

Dose release data generated from the PCTRAN calculation are used as input of RadPuff module. Information such as wind velocity, wind direction,

release height and pasquill conditions are referred from SKN 3&4 FSAR. Off-site dose rate was calculated from these data. (Figure 4 and 5) The result has a range of 0 to hundreds mRem in the case of whole body dose rate.

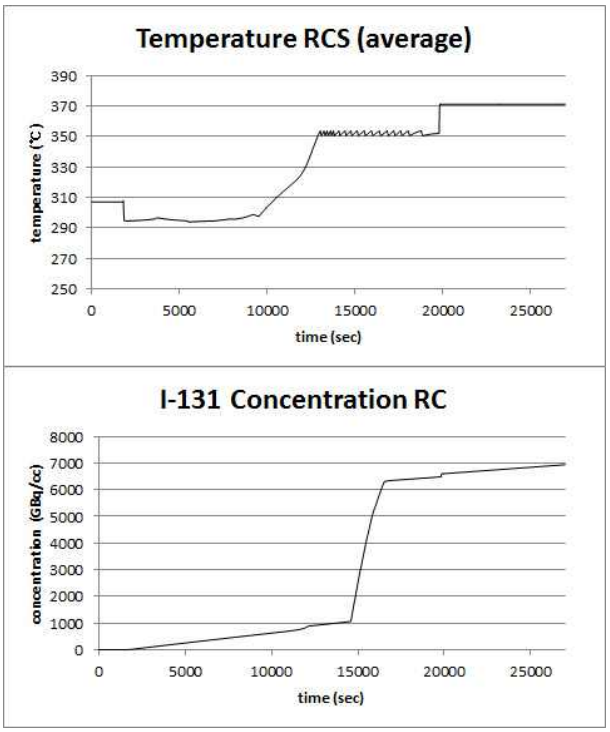

Fig. 3. Result of simulation

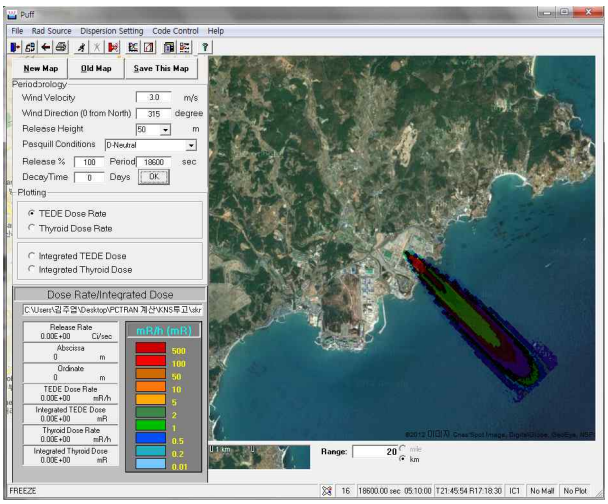

Fig. 4. Simulation of dose release

3. Conclusions

The SBO simulation and dose assessment at SKN 3&4 were performed with PCTRAN APR1400 and RadPuff. PCTRAN is a powerful and swift tool for accident simulation. Especially, it can be useful to establish the emergency response system for simultaneous accidents at multiple units such as Fukushima disaster. In further research, new version of PCTRAN APR1400 for simulation of the simultaneous accidents at multiple units will be developed. Therefore, it will be possible that dose assessment would be performed in very short time when the simultaneous accident at multiple units occurs. The result of the dose assessment can help the decision making in emergency response.

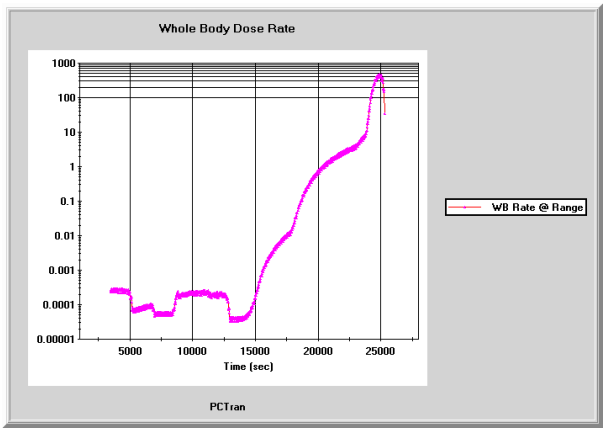

Fig. 5. Result of whole body dose rate

ACKNOWLEDGMENTS

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REFERENCES

[1] KHNP, SKN 3&4 FSAR (under evaluation)
[2] Li-Chi Cliff Po, "Personal Computer Transient Analyzer for a Two-loop PWR and TRIGA Reactor," MST (2009).
[3]] Li-Chi Cliff Po, " RadPuff Puff Dispersion Projector For Nuclear Power Plant or Radiological Device," MST (2011).