PLCSMF accident analysis using the SPACE code

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1. Introduction

The PLCSMF(Pressurizer Level Control System MalFunction) accident is the most serious event in terms of pressure of the reactor coolant system and performance of the fuel cladding among all events that can increase inventory of the reactor coolant system. This paper contains the results of the PLCSMF accident calculation using the SPACE code for Hanul nuclear power plant unit 5 and 6.

2. Sequence of the event and system operation

This accident analysis used SPACE 3.22 version. The nodalization used in this accident analysis is shown in Figure 1.

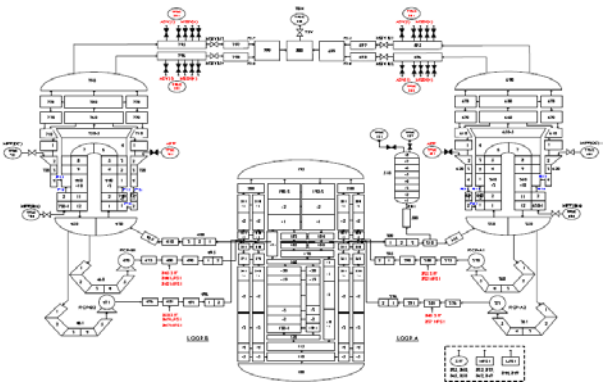

Fig. 1. SPACE nodalization

2.1 Plant Initial Conditions

The result of the steady-state analysis are shown in Table I.

Table I: Steady state analysis results

Parameter	FSAR	SPACE	Error (%)
Core power, MW t	2,871.3	2,871.3	0.0
Coolant Temp., K	565.37	566.9	0.27
Coolant Mass Flow, kg/s	14,643.16	14,709.12	0.45
PZR pressure, MPa	14.68	14.68	0.0
PZR volume, ㎥	29.62	29.64	0.07

2.2 PLCSMF Evaluation Results

The Table II shows the sequence of the event from the beginning of the accident until the operator stabilizes the power plant to start cooling down[1].

The transient behavior of the systematic variables according to the PLCSMF event is shown Fig. 2 through Fig. 5.

The PLCSMF event increases the inventory of the reactor coolant system by full opening the charge flow control valve while minimizing the letdown flow rate. Assuming that the pressurizer pressure control system is in a manual state with proportional water spraying turned off, the increase in inventory of the reactor coolant system raises the pressurizer pressure to 16.42 MPa, the reactor trip set point, at 228.01 sec.

Since the steam bypass control system is assumed to be in manual mode and the closing speed of the turbine stop valve is faster than the insertion speed of the control rod, the pressurizer pressure increases to 17.51 MPa, opening the pressurizer safety valves. The pressure of the reactor coolant system reaches the peak of 17.54 MPa at 233.03 sec. Although the heat flux of the core decreases and the pressure decreases when the pressurizer safety valve is opened, the pressure of the pressurizer increases again due to a reduction in heat transfer from the primary to the secondary due to loss of flow rate of the reactor coolant system to reach 14.88 MPa in 869.01 sec. The main steam safety valves open at 242.01 seconds as the pressure of the steam generator is increased due to the unavailability of the steam bypass valve. As the reactor trip, the core power is reduced, and the main steam safety valve is operated, the steam generator pressure does not rise more than 9.07 MPa in 242.11 sec.

Table II: Sequence of event

Time(sec)	Event	Set point
0	CFCV max. open	
228.01	Rx. trip signal by PZR high pressure	16.42 MPa
229.01	Rx. Trip	
229.11	Turbine trip	
233.02	PSV open	17.51 MPa
233.03	Max. pressure of the RCS	17.54 MPa
236.02	PSV close	14.29 MPa

242.01	MSSV open	9.06 MPa
242.11	Max. pressure of the SG	9.07 MPa
1,070.01	AFAS set point	19.9 % WL
1,117.01	Aux. feed start	
1,800.0	Operator cooling down	

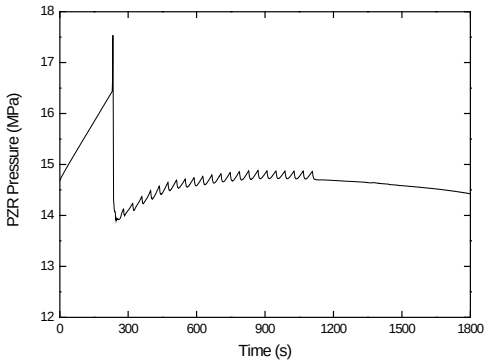

Fig. 2. PZR pressure

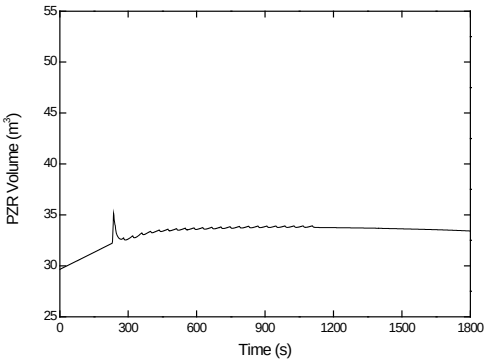

Fig. 3. PZR volume

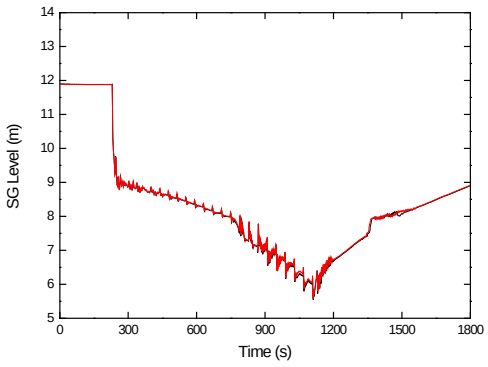

Fig. 4. SG level

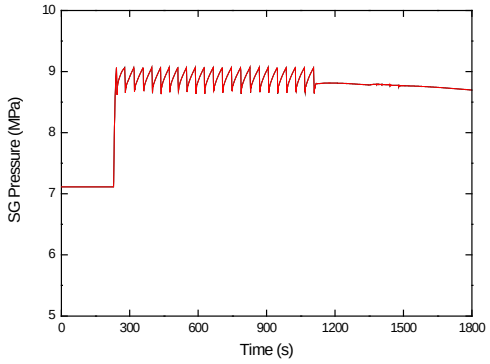

Fig. 5. SG pressure.

3. Conclusions

After simulating the PLCSMF event using the SPACE code, the peak pressure of the reactor coolant system reaches 17.54 MPa, which is less than to 18.96 MPa, 110% of the design pressure. In addition, during this event, the peak pressure of the steam generator reaches 9.07 MPa but is below 9.63 MPa, which is 110% of the design pressure. This event results in an increase in the pressure of the reactor coolant system due to an increase in the inventory of coolant in the reactor coolant system, which increases the DNBR. Therefore, the acceptance criteria for fuel performance are met.

REFERENCES

[1] Korea Hydro & Nuclear Power Co., Ltd ‘Final Safety Analysis Report for Hanul Unit 5 and 6’.