OPR1000 steady state analysis using the SPACE code

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1. Introduction

OPR1000 is a Standard Nuclear Plant design in Korea. Currently, this design is used at eight plants in Korea. Four additional reactors are under construction. SPACE verification for OPR1000, the most commonly used design in Korea, is important step. This study contains the SPACE analysis results for OPR1000 when in steady state. In addition, the OPR1000 input used in this study will be used to assess various accidents, and for transient state analysis and IET(Integral Effect Test) verification.

2. Methods and Results

The calculation uses a revised solver. The solver used here is the SPACE solver(SPACE_0.10_20110803a).

2.1 Analysis Method

The SPACE code input model of OPR1000 must satisfy a control and boundary condition for correct simulations of the main physical phenomena.

OPR1000 input can be largely divided into the following three parts. The input model components are the reactor vessel, primary cooling system(cold leg, hot leg, reactor cooling pump, and pressurizer and surge line), and the secondary cooling system(steam generator, and main steam line). The feed water system and the charging system, including the main feed water and auxiliary feed water was put into operation with specified flow boundary conditions.

Fig. 1 shows the components, cells, boundaries of the exact calculations, and the exact volume and height of each component. The hydraulic input component values are as follows.

- Reactor vessel : 110~290
- Pressurizer and surge line : 500~530
- Reactor cooling loop A : 300~376
- Reactor cooling loop B : 400~476
- Steam generator 1 and steam line : 604~690
- Steam generator 2 and steam line : 704~790

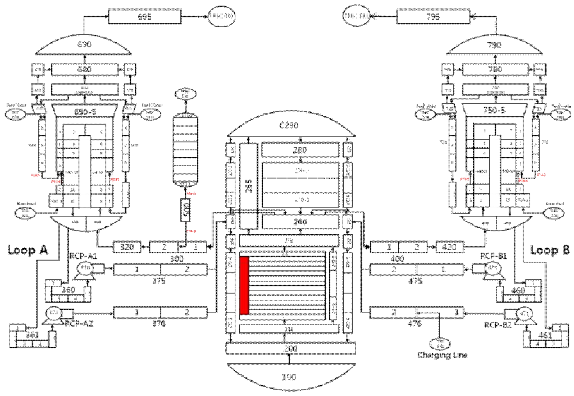

Fig. 1. OPR1000 nodalization

2.2 Analysis Results

The 100% full power steady state operating condition assumes a “steady” option. The calculation time is 500seconds.

Figure 2~4 shows the behavior of important variables in the calculation of the steady state process. All variables are steady, and the reactor power is 2815MW.

Table 1 provides a comparison of the steady state calculation values with the design values.

Table 1. OPR1000 steady state calculation results

	Plant Parameter	Design	SPACE
Reactor Vessel	Core power [MW]	2815	2815
	Core bypass flow [kg/s]	36.5	36.4
	Core flow [kg/s]	14944.8	14882.5
Primary Side	Hot leg flow rate [kg/s]	7648.8	7594.8
	Cold leg flow rate [kg/s]	3824.4	3797.4
	Hot leg temperature [K]	600.48	600.49
	Cold leg temperature [K]	568.98	568.96
	Pressurizer pressure [bar]	155.1	155.1
	Pump head [m]	102.7	99.5
	Pump torque [Nm]	38497.1	10154.2
	Pump speed [rpm]	1190.0	1166.0
Secondary Side	Downcomer flow rate [kg/s]	80.3	80.3
	Economizer flow rate [kg/s]	721.02	721.02
	Steam flow rate [kg/s]	801.3	801.1
	Steam pressure [bar]	73.774	73.335
	SG recirculation	3.7	3.6

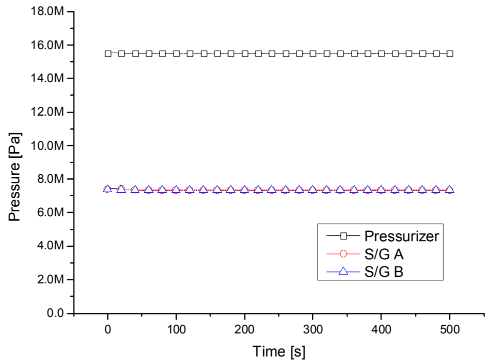

Fig. 2. Pressurizer and steam generator pressure

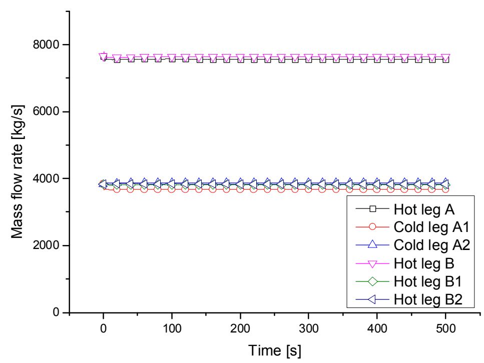

Fig. 3. Hot and cold leg flow rate

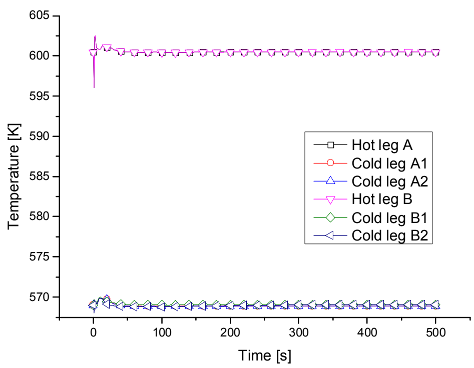

Fig. 4. Hot and cold leg temperature

3. Conclusions

This study outlines the development of the SPACE code input mode for the OPR1000 design. This input data is based on a steady state and can, be used to analysis various accidents and transient conditions.

An analysis of the input data used in this study, compared the physical phenomena of each component with the calculated value. The results confirm that input data can be used as the basic input in the OPR1000 SPACE code input model.

Acknowledgement

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