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Development of Reactor Core Model based on Optimal Analysis for Shinhanul # 1, 2 Simulator

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1. Introduction

As one of the outputs of "Development of the Shin Hanul Nuclear Plant(SHN) 1,2 Simulator" project which is being done by KHNP Central Research Institute, the SHN1,2 Simulator is being developed including the KNICS methodology and advanced Alarm Systems first applied to the Nuclear Power Plant in Korea, and the SHN 1,2 simulator adopts the virtually stimulated HMI(Human-Machine Interface) for the non-safety MMIS system, whose key-programs are identical to those applied to the real SHN 1,2 plants. The purpose of this paper is to develop localization core model by integrating the Simulator system with the Simulator core model though technology agreement of KAERI

2. Methods and Results

In order to produce core model for SHN1,2, Calculating a three-dimensional lattice cross section through a reactor core calculation of a variety of conditions. And by using this calculation, the cross section changes should be functionalization in accordance with the basic cross section and the operation conditions change.

To produce such a cross section, we must build core model which can analyze three-dimensional core model. By comparing major nuclear design factors, such as boron concentration, power distribution, with design value, it verified the applicability of model.

2.1 MASTER Cross section production

In order to produce the first cycle reactor core model of the MASTER_SIM code for Simulator, produce cross-section of MASTER by using nuclear design system of CASMO3/MASTER. There is no data of reflector analysis for SHN1,2. So it was used to adjust Transport cross section of reflector cross section for the OPR-1000(YG3,4).

2.2 MASTER model production and validation

Performs a MASTER burn up calculation by using the cross section of MASTER. It compares the power distributions of the critical boron concentration, BOC (0MWD/MTU), MOC (13992MWD/MTU) and EOC (17571MWD/MTU) with the ROCS result. Maximum Critical boron concentration is 22ppm. This value is within tolerance of 50ppm. Radial power distribution difference is maximum 3.4%, and axial power distribution is maximum 4.7%. All of these value are in agreement with within 5% tolerance.

2.3 MASTER-SIM reactor core model production

MASTER_SIM has an input/output structure shown in Figure 1. MASTER_SIM require four types of input file. So, the core model production of MASTER_SIM means for producing the four files of XSFILE, DHFILE, DYFILE and TNFILE. Production flow chart of the model is shown in Figure 2..

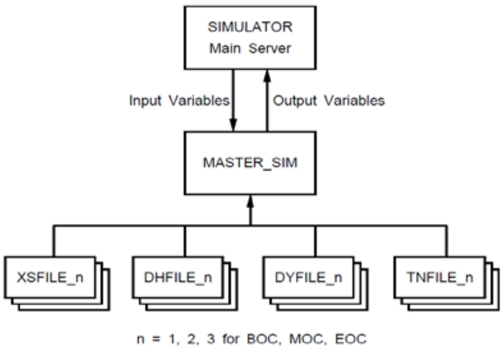

Figure 1 MASTER_SIM input/output structure

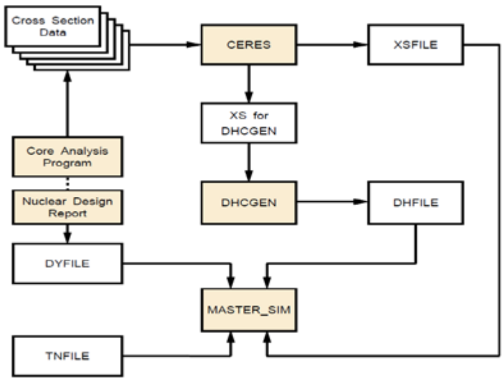

Figure 2 MASTER_SIM model production flow

2.4 MASTER-SIM reactor core model validation

To validate the MASTER_SIM reactor core model, make MASSIM_SS program that performs only the steady-state simulator calculations and it performed steady-state Calculation for verification. MASSIM_SS is a program that implements the same steady-state analysis of the MASTER_SIM code. Model validation is compared with the design value by calculating the distribution of full power ARO condition and rod worth of HFP and HZP condition. Because SHN 1,2 nuclear design report was not published, Design values are the reference ShinKori 3,4 one cycle nuclear design of the same report design. The design values reflect the as-built value, there are some differences, such as fuel assemblies enrichment but Not affect the performance verification of the simulator. Table 1 and Table 2 show the results of comparing the values of MASSIM_SS calculation of critical boron concentration, rod worth, and the NDR calculation. And MASSIM_SS results of calculation are good consistent with NDR. In case of radial power distribution at the edge of maximum difference of 4.4 percent. But This power distribution can be found in a good agreement with the low power areas and less than 5% conventional tolerance range.

Power	Bank Insertion	Critical Boron Concentration (ppm)		
		NDR	MASSIM_SS	Diff.
HFP	ARO	827	814	-13
HZP	ARO	1197	1198	1

Power	Bank Insertion	Bank Worth (pcm)		
		NDR	MASSIM_SS	% Diff.
HFP	5	293	297.7	1.6
	5+4	714	732.1	2.5
	5+4+3	1473	1488.4	1.0
	5+4+3+2	2447	2461.1	0.6
	5+4+3+2+1	3774	3772.7	0.0
	5+4+3+2+1+B	8501	8522.8	0.3
	ARI	14372	14319.6	-0.4
	P	193	188.1	-2.6
HZP	5	241	244.7	1.5
	5+4	666	672.7	1.0
	5+4+3	1287	1296.4	0.7
	5+4+3+2	2215	2193.8	-1.0
	5+4+3+2+1	3183	3133.2	-1.6
	5+4+3+2+1+B	7638	7535.4	-1.3
	ARI	13072	12812.6	-2.0

3. Conclusions

To develop ShinHanul 1 & 2 reactor core simulator model, KHNP and KAERI create MASTER-SIM model and tried validation. And calculations of MASSIM_SS program for MASTER_SIM validation, are within tolerance range. Test has not yet been completed. And many verification will be conducted

MASTER-SIM software is expected to be the highest economic software and satisfy international simulator standards.

REFERENCES

[1] Quarterly report of Development of Core/TH model for Shinhanul Simulator#1,2., 2015.

[2] ANSI/ANS -3.5, "Nuclear Power Plant Simulators for Use in Operator Training and Examination, 1998.