Preparation of Input Deck using MULTID Component to Model 3-Dimensional Reactor Pressure Vessel for KORI 3&4

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1. Introduction

This paper presents an effort made to verify the MARS-KS input decks to be used to analyze domestic NPP transients and accidents. It includes development and verification of the input decks for the MARS-KS MUTID component. This effort aims at developing the input decks qualified to be used for regulatory audit calculation [1].

The verification process is mainly divided into two steps: the first step is to compare the existing 1-dimensoinal (1-D) input deck to the calculation note in order to verify the consistency, and the next is to model 3-dimensional (3-D) reactor pressure vessel using MULTID component instead of the existing 1-D input deck.

2. Methods and Results

In this section, we describe the procedure of preparation of the input deck for regulatory audit calculation. Also, we show the results of the steady state calculation about the input deck using the MULTID component to model 3-D reactor pressure vessel for Kori unit 3&4.

2.1 Procedure for preparation of input deck

The input deck of Kori unit 3&4 has been prepared through follow the procedure.

1) Acquisition of the existing input deck: It obtained the input deck, calculation note, final report as the findings of the project "Development of best-estimate analyzer for PWR" [2].
2) Verification of the existing input deck: It verified the consistency between the results of the steady state calculation for the input deck and the operation data of a NPP.
3) Conversion of 3-D core: a part of the reactor pressure vessel is converted from 1-D input deck to 3-D input deck. And, it prepared the calculation note for the 3D input deck.
4) Verification: The completed input deck was evaluated to verify the consistency between the results of a steady state of the completed input deck and a NPP condition. If the result is not satisfied, we get the satisfied results by re-performing the procedure of (2) and (3).

2.2 Modeling for 3D input deck

A 3-D input deck should be converted using the verified 1-D input deck. The conversion of the 3-D input deck was modeled using the MULTID component classifying the multi-dimensional thermal-hydraulic volume, heat structure and fuel.

To model the multi-dimensional thermal hydraulic volume, the reactor pressure vessel was modeled with 5 radial rings, 6 azimuthal sectors, and 23 axial nodes. Here, the axial node of each component was based on the verified 1D input deck. The core region possesses 4 radial, 6 azimuthal, 14 axial grids. It is assumed that the fuel assemblies are homogeneously distributed only in inner 3 radial grids. The outer 1 radial grid region is modeled as the core bypass. The outer-most 1 radial grid is used for the downcomer region.

To model the multi-dimensional heat structure, the heat structure corresponding to the multi-dimensional thermal hydraulic volume was modeled again for the multi-dimensional reactor pressure vessel.

To model the multi-dimensional fuel, the core region was modeled with 24 heat structures for an assembly located in the given rings and sectors. The average rod was simulated in inner 3 rings and 6 sectors. The hot rod was also simulated in inner-most ring and 6 sectors.

Figure 1 shows the horizontal cross-sectional diagram of the multi-dimensional node for the reactor pressure vessel of Kori unit 3&4.

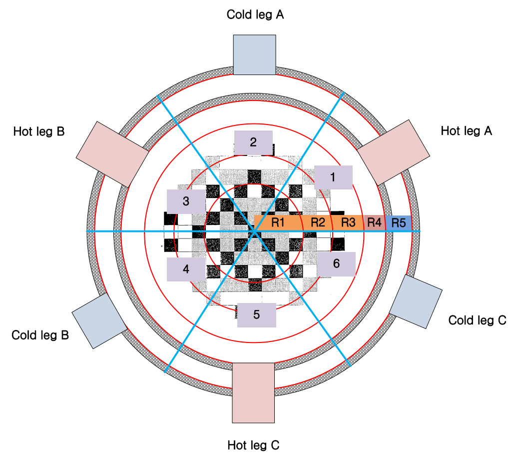

Fig. 1 Horizontal cross-sectional diagram of the multi-dimensional node for the reactor of Kori unit 3&4.

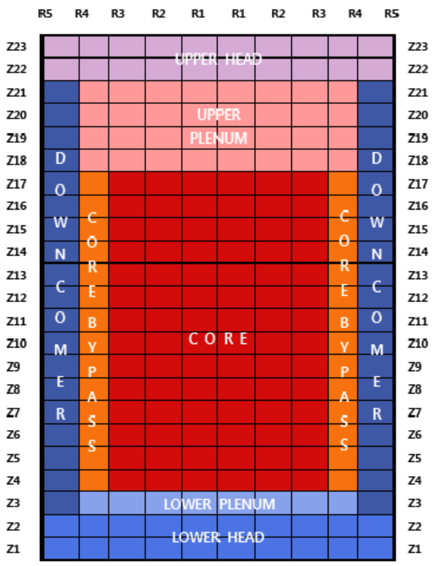

Fig. 2 Vertical cross-sectional diagram of the multi-dimensional node.

Figure 2 shows the vertical cross-sectional diagram of the multi-dimensional node for the reactor pressure vessel of Kori unit 3&4.

2.5 Result

Table 1 Comparison of the result for the calculation

	Plant Parameter	Design	1-D Cal.	3-D Cal.
Reactor	Core Power [MWt]	2775.0	2775.0	2775.0
	Reactor pressure drop [bar]	2.83	3.225	3.361
	Fuel Assembly Pressure Drop [bar]	1.78	1.988	2.009
Primary Side	Loop 1 Flowrate (BE) [kg/s]	4582.123	4618.4	4574.7
	Hot Leg Temperature [K]	599.76	599.48	599.82
	Cold Leg Temperature [K]	564.82	564.88	564.87
	Temperature Rise[K]	34.94	34.6	34.95
	PZR Level [%]	58	57.749	59.422
	PZR Pressure [bar]	155.1	155.134	155.147
	Pump Head [m]	85.344	66.30756	66.90817
	Pump Torque [Nm]	42062	35917	35983
	Pump Speed [rpm]	1185	1184.972	1184.972
	Primary Side SG Pressure Drop [bar]	2.83	2.619	2.554
Secondary Side	Feedwater Flowrate [kg/s]	516.17	519.05	519.11
	Steam Flowrate [kg/s]	516.17	519.12	519.66
	Steam Pressure [bar]	66.465	66.1627	66.2049
	SG Level [%]	50	49.866	49.865
	SG Recirculation Ratio	-	3.7157	3.7139

To verify the consistency between the values of the 3D calculation and those of the verified 1-D calculation, the steady-state calculation of the 3-D input deck was performed for 300 seconds.

The results of the 3-D calculation are shown in Table 1. The steady-state results of both the 1-D and 3-D calculation show a good agreement with the design data to within an error bound.

3. Conclusions

We are performing verification of the MARS-KS input decks to be used to analyze domestic NPP transients and accidents. The verification includes development of the input decks for the MUTID component, supported by a systematic procedure from acquisition of the existing 1-D input deck to verification of the developed 3-D input deck.

This effort will help maintaining the input decks qualified to be used for regulatory audit calculation.

Acknowledgment

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