Simulation of PKL-III G3.1(MSLB) Experiment for verification of SPACE code

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1. Introduction

The Korea nuclear industry has developed a best-estimated two-phase three-field thermal-hydraulic analysis code, SPACE (Safety and Performance Analysis Code for Nuclear Power Plants), for safety analysis and design of a PWR (Pressurized Water Reactor). As the first phase, the demo version of the SPACE code was released in March 2010. The code has been verified and improved according to the Verification and Validation (V&V) matrix prepared for the SPACE code as the second phase of the development.

In this study, PKL-III G3.1 experiment has been simulated using the SPACE code as one aspect of the V&V work. The results from this experiment were compared with tests of the SPACE and MARS codes.

2. PKL-III G3.1 Experiment Modeling

2.1 PKL-III Test Facility

The PKL (Primär-Kreis-Lauf)-III test facility simulates a typical 1300 MWe Pressurized Water Reactor of Siemens. The PKL test facility simulates the entire primary with 4 loops and the essential part of the secondary side on a volume and power scale of 1:145. All components heights correspond to real plant dimensions. PKL is also equipped with all relevant engineered safety and operational systems on the primary and secondary side (e.g. four independent high- and low pressure safety injection systems connected to both the hot and cold legs, 8 accumulators, pressurizer pressure control system). This allows the simulation of a wide spectrum of accident scenarios, the interaction between the primary and secondary side in combination with various safety and operational systems. The PKL test results have been used for the validation of thermal hydraulic system codes concerning reactor safety analyses such as RELAP5, for preparation and verification of procedures described in the operational manuals and for answering questions of current interest arisen by licensing authorities.

2.2 G3.1 Experiment

In test G3.1, the influence of MSLB (Main Steam Line Break) accident was investigated.

G3.1 experiment is divided two processes. One is called “Conditioning Phase” for setup initial condition of accident. Second step is called “Test Phase” for MSLB accident modeling.

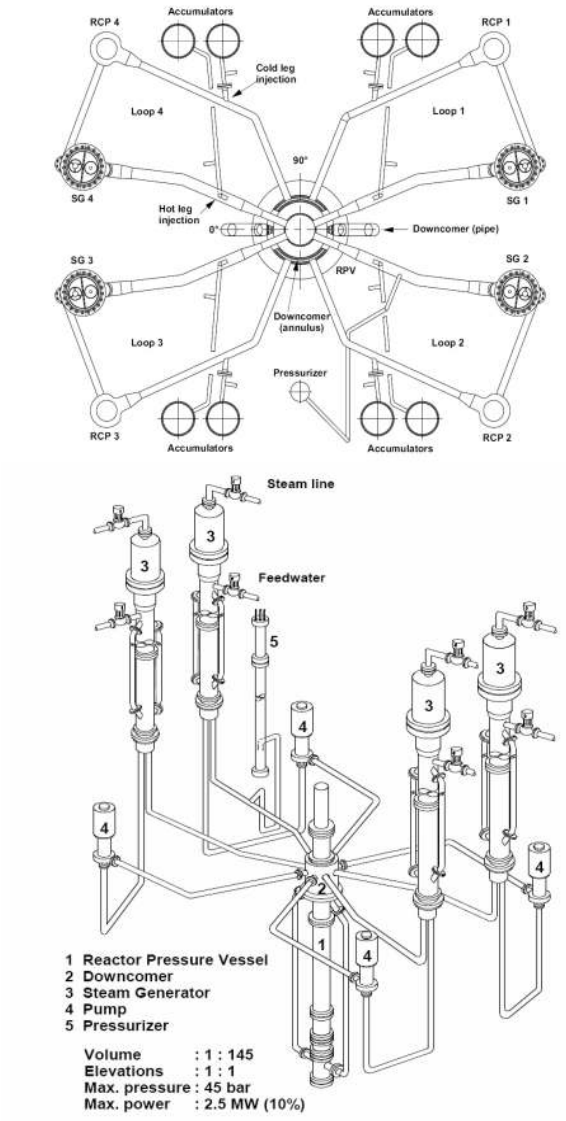

Fig. 1. PKL Test Facility

In the Conditioning Phase, All working fluid is single liquid state in PKL system except for pressurizer. Pressurizer is saturation condition and is maintained 42bar using the pressurizer heater. SG pressure is maintained 35bar. The other conditions are presented in the following table1.

Table 1. PKL-III G3.1 Initial major variable

Viriable	Value
Coolant Inventory	Single liquid(except for Pzr)

Heat rod thermal power	260kW
Pressure	42 bar(Pzr) / 35bar(SG)
Core exit Temp. & subcooled Temp	246 °C / 7°C
Pressurizer level	9.2m(broken), 12.2 ~ 12.3(intact)
SG secondary side level	
Primary side flow rate	34 Kg/s(per Loop)
RCP Pump speed	2500 rpm
Primary side heat generate rate	12 K/h

In the Test Phase, Experiment process is divided two steps. First step is performed until SG coolant inventory is exhausted by MSLB accident. Second step is performed during pressurizer safety valve is operated to open and close action because of pressurizer pressure and level increase by Safety Injection to primary system

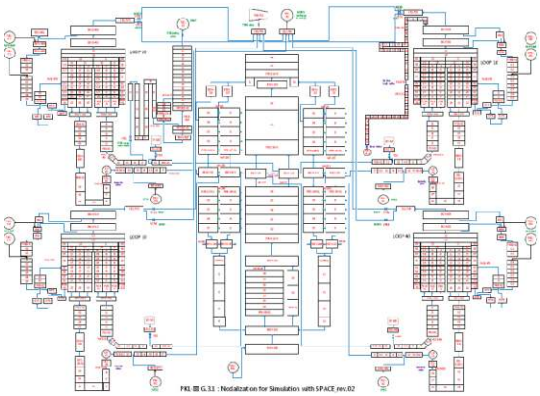

Fig. 2. PKL-III G3.1 SPACE Nodal Diagram

2.3 G3.1 Experiment modeling using the SPACE code

SPACE code input for PKL-III G3.1 is made using the MARS-KS code for PKL-III G3.1.

In this paper, SPACE code input for PKL-III G3.1 is performed using the SPACE 1.3. Basically, all initial conditions and assumptions used in PKL-III G3.1 experiment were equally adapted to the SPACE input deck of PKL-III G3.1 experiment.

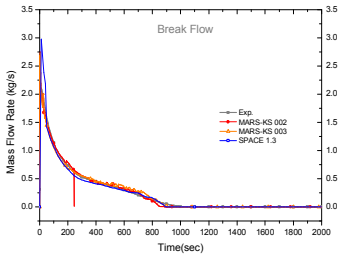

Fig. 3. PKL-III G3.1 Break Flow

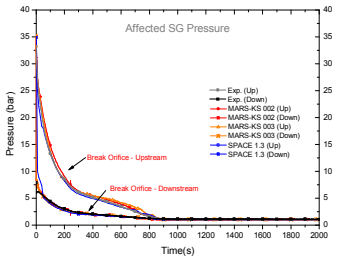

Fig. 4. PKL-III G3.1 Affected SG pressure

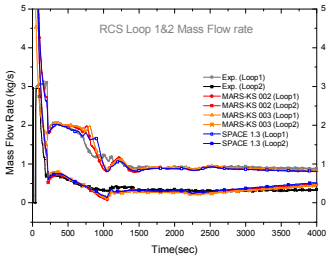

Fig. 5. PKL-III G3.1 RCS Loop 1&2 Mass Flow rate

3. Conclusions

The Korean nuclear industry has been developing the SPACE code for safety analysis and design of a PWR. PKL-III G3.1 experiment has been simulated using the SPACE code for the SPACE code V&V. The results have been compared with those for the MARS code and experiment.

Through this evaluation of a PKL-III G3.1 experiment using the SPACE code, it is concluded that the SPACE code has the capability to predict the system response for the PKL-III G3.1 experiment.

Acknowledgements

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