Validation tests of SPACE code for analysis of reactivity insertion in IAEA benchmark research reactor

DongHyun Kim[a*], Cheol Park[a], Dongwook Jang[b] and Su-Ki Park[a]
[a]Research Reactor Engineering Division, KAERI, 111, Daedeok-Daero 989 Beon-Gil, Yuseong-gu, Daejeon, Korea
[b]KiJang Research Reactor Design & Construction Agency, KAERI, 111, Daedeok-Daero 989 Beon-Gil, Yuseong-gu, Daejeon, Korea
*Tel : +82-42-866-6319, Email : dhkim1113@kaeri.re.kr

1. Introduction

- In this study, reactivity insertion transients in a research reactor of IAEA benchmark were simulated using the SPACE to validate the SPACE for the analysis of transients in research reactors. And the simulation results were compared with those by the RELAP5 code which has been used for safety analysis of many research reactors in order to identify the applicability of the SPACE to safety analysis of research reactors.

2. Research reactor in IAEA benchmark

- The IAEA benchmark problems included in IAEA TECDOC-233 and 643 were specified in order to compare calculation methods used in various research centers and institutions.

Table 1. Specifications of IAEA benchmark

Reactor	
Reactor type	Pool type MTR
Steady state power	10 MW
Coolant, Moderator	H_2O
Reflector	Graphite, H_2O
Fuel & control assembly	
Type	Plate
Number – Standard Assembly	23
Number – Control Assembly	5
Size	76 x 80 x 600 mm
Total number of fuel plates in core	614
Material – Meat	19.75% enriched U_3Si_2 alloy
Material – Cladding	Al

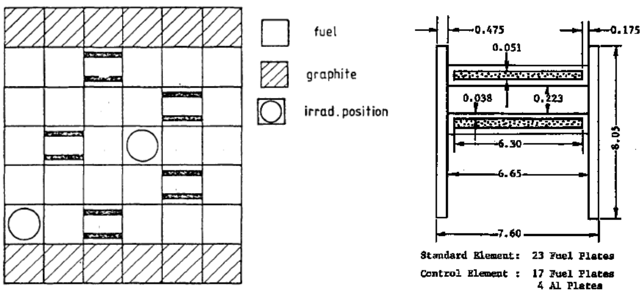

Fig. 1. Core configuration and fuel element of IAEA benchmark

3. Calculation methods

Table 1. Initial conditions for the analysis of reactivity insertion transients

Parameter	Value
Initial power level	1 W
Radial peaking factor	1.4
Axial peaking factor	1.5
Engineering factor	1.2
Core flow rate	275.9 kg/s
Coolant inlet temperature	38 ℃
Coolant inlet pressure	1.7 bar
Effective delayed neutron fraction	727.5 pcm
Mean neutron generation time	43.74e-6 s
Coolant temperature reactivity coefficient	-1.0930e-2 $/K
Fuel temperature reactivity coefficient	-3.3456e-3 $/K

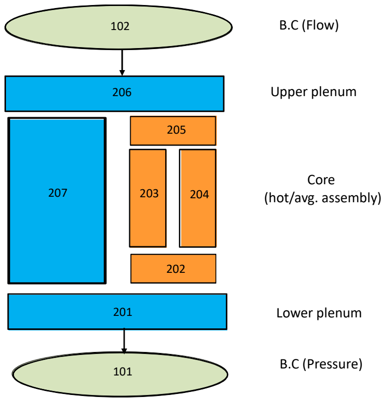

Fig. 2. Node diagram of IAEA benchmark

- fast insertion transient: 1.5$ during 0.5sec
- ramp insertion transient: continuous insertion of 0.09$ per second

4. Results and conclusion

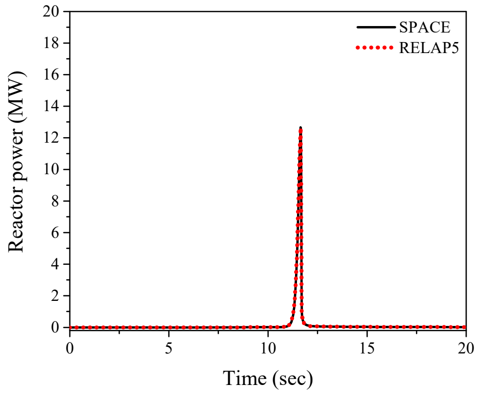

Fig. 3. Fast insertion: Reactor power

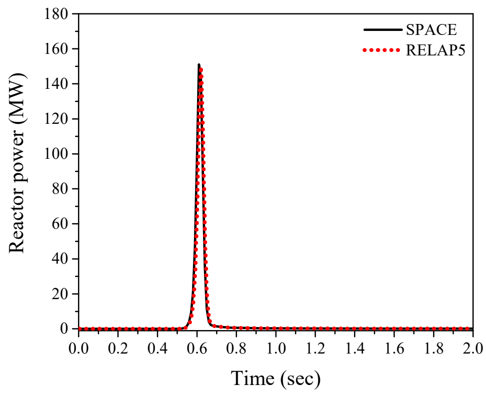

Fig. 4. Ramp insertion: Reactor power

- Fig. 3 present the analysis results of the fast insertion transients. The reactor power increases sharply since the positive reactivity of 1.5$ is inserted into the core in a very short time of 0.5 seconds. Reactor trip occurs by the high reactor power and the reactor power decreases rapidly. The reactor power variation by the SPACE is almost the same as that by the REALP5. The peak reactor power levels are 151.0 MW in SPACE and 149.8 MW in RELAP5/MOD3.3, respectively.
- Fig. 4 presents the analysis results of the ramp insertion transient. The sequence of the event is the same as in fast insertion case but it is relatively slow transient. The peak reactor power levels are 12.66 MW in SPACE and 12.64 MW in RELAP5/MOD3.3.