Transient analysis of a reactivity insertion accident induced by the withdrawal of a single control rod in the KJRR

Donghyun Kim* and Jong-Pil Park
Research Reactor Design Division, Korea Atomic Energy Research Institute,
111, Daedeok-Daero 989 Beon-Gil, Yuseong-Gu, Daejeon, 34057, Korea
**Corresponding author: dhkim1113@kaeri.re.kr*

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1. Introduction

The Ki-Jang Research Reactor (KJRR) is a research reactor to produce various radioisotopes currently under construction in Ki-Jang. In this study, a reactivity insertion accident induced by the withdrawal of a single control rod was simulated and analyzed to evaluate the safety margin.

2. Methods and Results

2.1 Calculation model and method

The transient simulations were performed using RELAP5/MOD3.3[1]. Figure 1 shows the calculation model for transient calculations of KJRR. The model consists of reactor, primary cooling system (PCS), safety residual heat removal system (SRHRS) and reactor pool. The initial conditions, including reactivity insertion rate, were selected based on a sensitivity analy sis of each parameter to ensure the most conservative re sults with respect to safety limits.

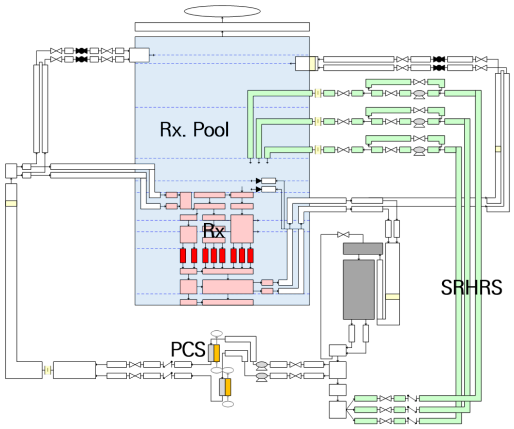

Fig. 1. Simplified diagram of the KJRR calculation model

2.2 Calculation results

In the event of an inadvertent withdrawal of a control rod, the reactor power increases due to the insertion of positive reactivity. As the fuel and coolant temperatures rise, the power increase rate is mitigated by the reactivity feedback effect. When high linear power or high logarithmic power rate reactor trip signals are generated, the reactor protection system shuts down the reactor, maintaining the core in a safe condition.

Figures 2 and 3 show the core power and minimum critical heat flux ratio (MCHFR) from calculation results considering various reactivity feedback conditions: case 1 with both fuel temperature and coolant temperature feedbacks, case 2 with only fuel temperature feedback, and case 3 with no feedback. With the exclusion of reactivity feedback effects, the maximum power decreases, and the minimum critical heat flux ratio (MCHFR) increases. Even in the extreme case where reactivity feedback effects are not considered, safety limits are not violated.

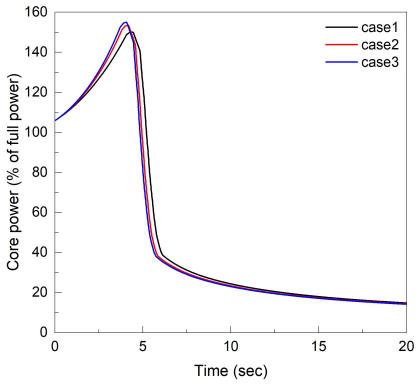

Fig. 2. Withdrawal of a single control rod: core power

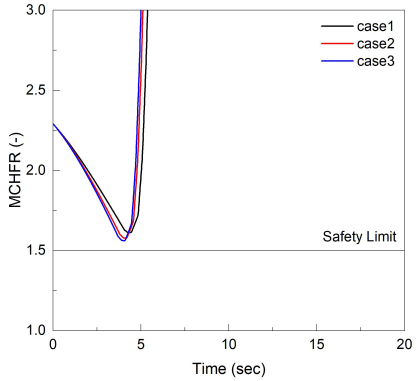

Fig. 3. Withdrawal of a single control rod: MCHFR

3. Conclusions

The transient analyses of a reactivity insertion accide nt induced by the withdrawal of a single control rod wer

e performed. The calculation results confirmed that even under highly conservative conditions, safety limits were not violated, thereby demonstrating the safety of the KJ RR.

ACKNOWELGEMENTS

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REFERENCES

[1] RELAP5/Mod3.3, Code Manual Volume V, User's Guideline, NUREG/CR-5535/Rev1, 2001