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Development of Trend Map on the Departure from Nucleate Boiling Ratio in Non-Loss of Coolant Accidents of Nuclear Power Plant

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Extended Abstract

As there have been increasing public concerns and strength of regulation on nuclear power plants' safety since the Fukushima nuclear accident occurred, nuclear safety methodology rapidly evolved to get a safety margin from conservative to realistic methods. Realistic methodology on the analysis in nuclear safety has advantages that process and the result of this is likely not only to be logical but also to obtain a larger safety margin [1]. However, the safety margin on the regulatory acceptance criteria might be reduced from the viewpoint of regulation.

For these reasons, it is essential to analyze the sensitivity study on the initial and conservative assumptions of nuclear operating conditions. Even though safety analysis was performed using the realistic methodology, the harshest conditions of nuclear operation should be applied to safety analysis to compensate for the uncertainty of simulation [2].

This study is to develop a trend map on the initial and conservative condition of non-LOCAs through a sensitivity study focused on the departure from nucleate boiling ratio (DNBR), which is one of the regulatory acceptance criteria.

Major transients such as main steam line break, main feed line break, seized reactor coolant pump rotor and steam generator tube rupture which are postulated accidents according to the safety review plan by USNRC, were studied to develop the trend map on the DNBR by sensitivity study in the range of limiting condition of operation of advanced power reactor 1400 designed by Republic of Korea [3]. The used system code was MARS-KS [4], which is an independent regulatory thermal-hydraulic code.

Core power, core flow rate, pressurizer level and pressure, core inlet temperature, and steam generator level were selected as initial conditions. Loss of off-site power was considered as a conservative assumption.

The sensitivity results of each transient were shown different trends on the DNBR because each transient's system behaviors were different by their own scenario. However, the reduced core flow rate adversely affected to DNBR in most transients.

The trend map presented in this study could give an insight on the initial or conservative assumption to deal with simulation uncertainty, and these results could directly apply to another code such as sub-channel or uncertainty analysis.

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References

[1] J Zhang, A Kovtonyuk, C Schneidesch, "Towards a graded application of best estimate plus uncertainty methodology for non-LOCA transient analysis," *Nucl Eng Des,* 2019, pp. 110-189.
[2] USNRC, *Regulatory Guide 1.203: Transient and Accident Analysis Methods*, USNRC, 2005.
[3] I.S. Lee, *Development of regulatory audit methodology and criteria on core coolability for design basis accidents*, KINS/RR-1856, 2019.
[4] KINS, *MARS-KS code manual volume II: input requirements*, KINS/RR-1282 Rev.1, 2016.