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Synergy Sustainable Ubiquitous

Study on Thermal-Hydraulic Safety Analysis of the New Research Reactor to be Installed at the Monju Site

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Introduction

Background In JAEA, we have been designing and preparing an application of construction permits of the new research reactor (NRR) to be installed at the Monju site. A safety assessment is needed for the application of construction permits of the NRR.

➡ **RELAP5** is used as thermal-hydraulic analysis code for the safety assessment in the project.

Issue : RELAP5 has never been used for an application of research reactor (RR) construction permits in Japan.

*RELAP5 is developed in U.S.NRC and widely used for safety assessment in nuclear reactors.

Objective To confirm an applicability of RELAP5 to a safety assessment of RRs.

Measures : Benchmarks of RELAP5 against analysis codes that have a track record of an application of RR construction permits are performed.

Analysis codes for RRs : COOLOD-N2 (steady-state), THYDE-W (transient : LOCA, pump failure), EUREKA2 (transient : reactivity insertion)

Contents The results of RELAP5 and COOLOD-N2 were compared to confirm the applicability of RELAP5 to RRs in steady-state condition.

(Specifically, temperature distribution, DNBR and ONB margin, which are the important for a safety assessment of RRs, were compared.)

Object of the benchmark : JRR-3 normal operation condition in forced convection

Simulation Conditions

Simulations were performed in 2 cases as follows :
Case1. Uniform Heat Generation
Case2. Considering Peaking Factors

JRR-3 operation condition in forced convection

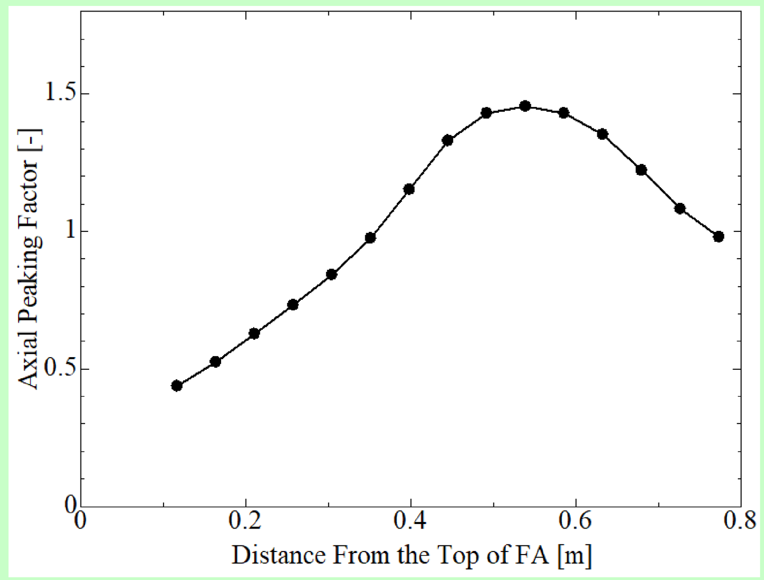
Num. of Standard Fuel	26
Heat Generation [MW]	20
(Standard Fuel)	17.4
Inlet Flow Rate [m³/h]	2400
(Standard Fuel)	1850
Inlet Coolant Temp. [°C]	35
Inlet Pressure [MPa]	0.152

Specification of Standard Fuel in JRR-3

Coolant Channel	Number of Channels	20
	Width [mm]	66.6
	Thickness [mm]	2.35
	Flow Area [cm²]	32.99
	Hydraulic Diameter [mm]	4.56
Fuel Plate	Number of Fuel Plates	21
	Width [mm]	71
	Thickness [mm]	1.27
	Length [mm]	770
Fuel Meat	Width [mm]	61.6
	Thickness [mm]	0.51
	Length [mm]	750

Peaking Factors Used in Case2

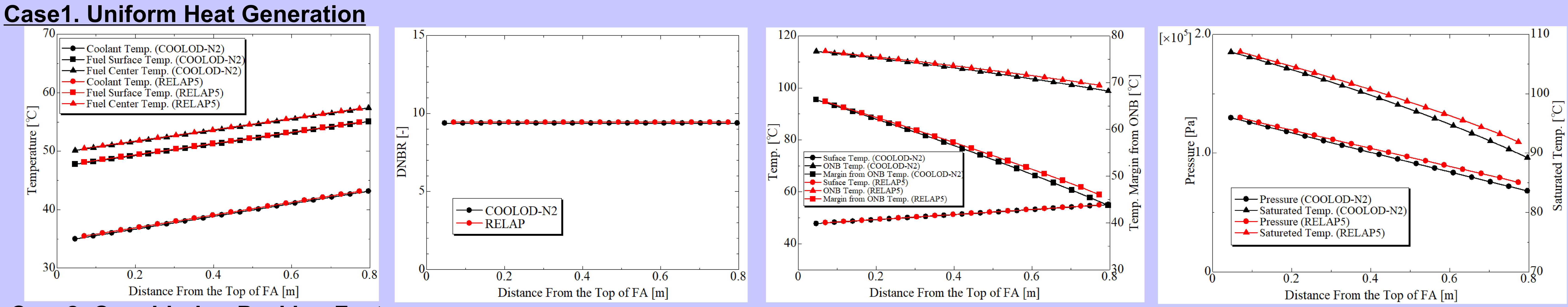
F_r	Radial Peaking Factor	1.664
F_L	Local Peaking Factor	1.360
F_b	Engineering Peaking Factor for Bulk Temperature Rise	1.320
F_f	Engineering Peaking Factor for Film Temperature Rise	1.360
F_{hf}	Engineering Peaking Factor for Heat Flux	1.160



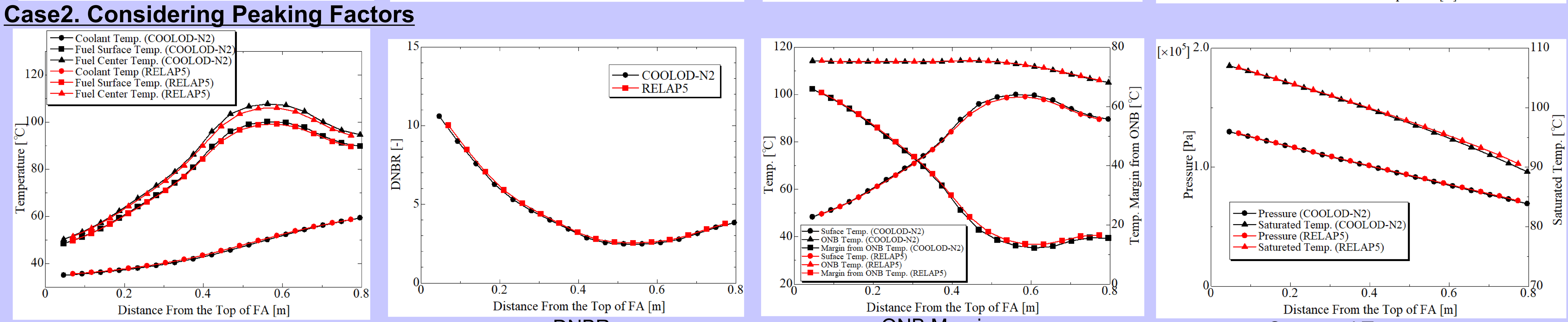
Axial Peaking Factor F_z used in Case2

Simulation Results

Case1. Uniform Heat Generation



Case2. Considering Peaking Factors



Temperature Distribution DNBR ONB Margin Saturated Temperature

- Temperature distribution and DNBR shows the good agreement.
- ONB temperatures in case1 are slightly different (2-3℃), but it is not a large difference from the viewpoint of a safety assessment.

Conclusions

To confirm the applicability of RELAP5 to RRs, the benchmarks of JRR-3 steady state condition between RELAP5 and COOLOD-N2 were performed.

✓ Temperature distribution, DNBR, ONB temperature and ONB margin were almost agree from the viewpoint of a safety assessment.

The applicability of RELAP5 to RRs in steady-state condition was confirmed by the benchmarks performed in this presentation.

Future Work

Other benchmarks, such as natural convection and transient conditions, will be performed to confirm the applicability of RELAP5 in other conditions.

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