Vietnam Conference on Nuclear Science and Technology (VINANST-14)

Evaluation of various thermal-hydraulics models for Nuclear Research Reactor WWR-SM Tashkent using best-estimate code RELAP5/Mod.3.3

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Content

- Introduction;
- Purpose;
- WWR-SM;
- IRT-4M;
- RELAP5 model;
- Result.

Introduction

- TRUONG Hoang Tuan;
- From: Ho Chi Minh city, Vietnam;
- Background education:
  - Bachelor of Aerospace Engineering (Honours) – Monash University, Australia;
  - Bachelor of Commerce, Monash University – Australia;

Purpose

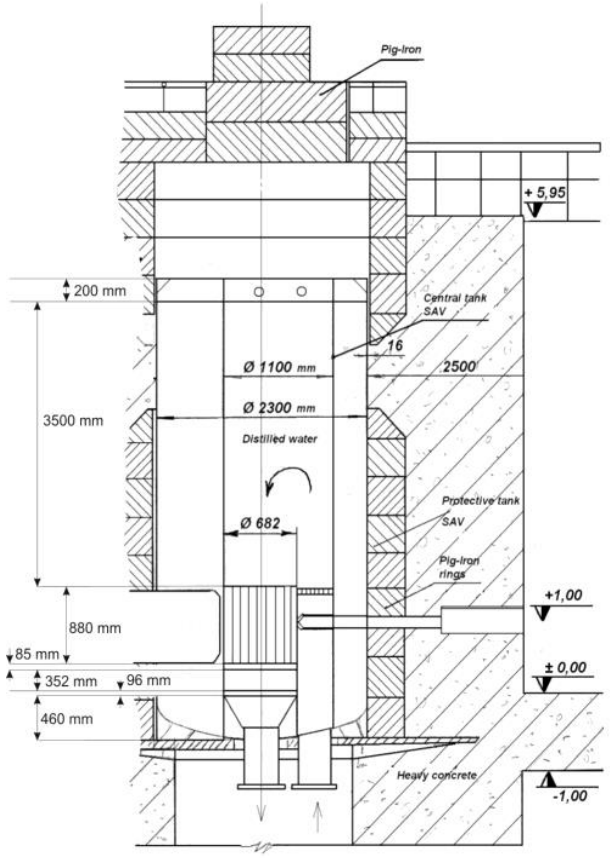
- RCNEST Project – collaboration between Russia and Vietnam;
- A new research reactor (~ 10 MW) based on Russian technology;
- Develop a group at Cenutech with modelling and simulation capabilities to support the RCNEST project.

WWR-SM

- At the Institute of Nuclear Physics (INP) in the Republic of Uzbekistan
- Has been operating since 1979;
- Nominal power is 10 MW;
- Converted from HEU to LEU.

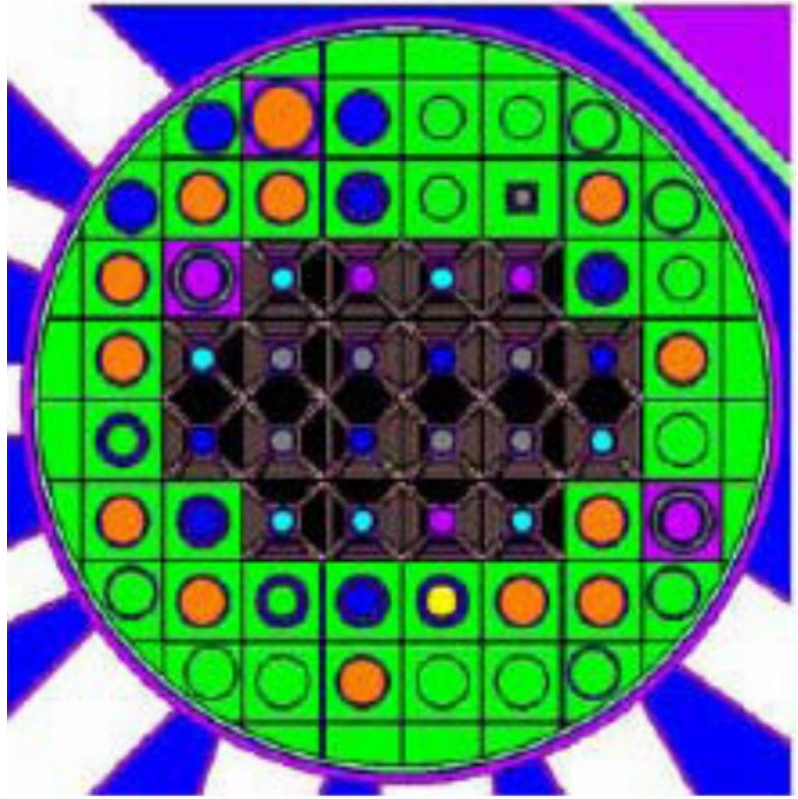
WWR-SM (cont.)

- Coolant type: Water;
- Circulation loop: 1 circuit;
- Nominal moderator temperature: 45 ^{o}C.



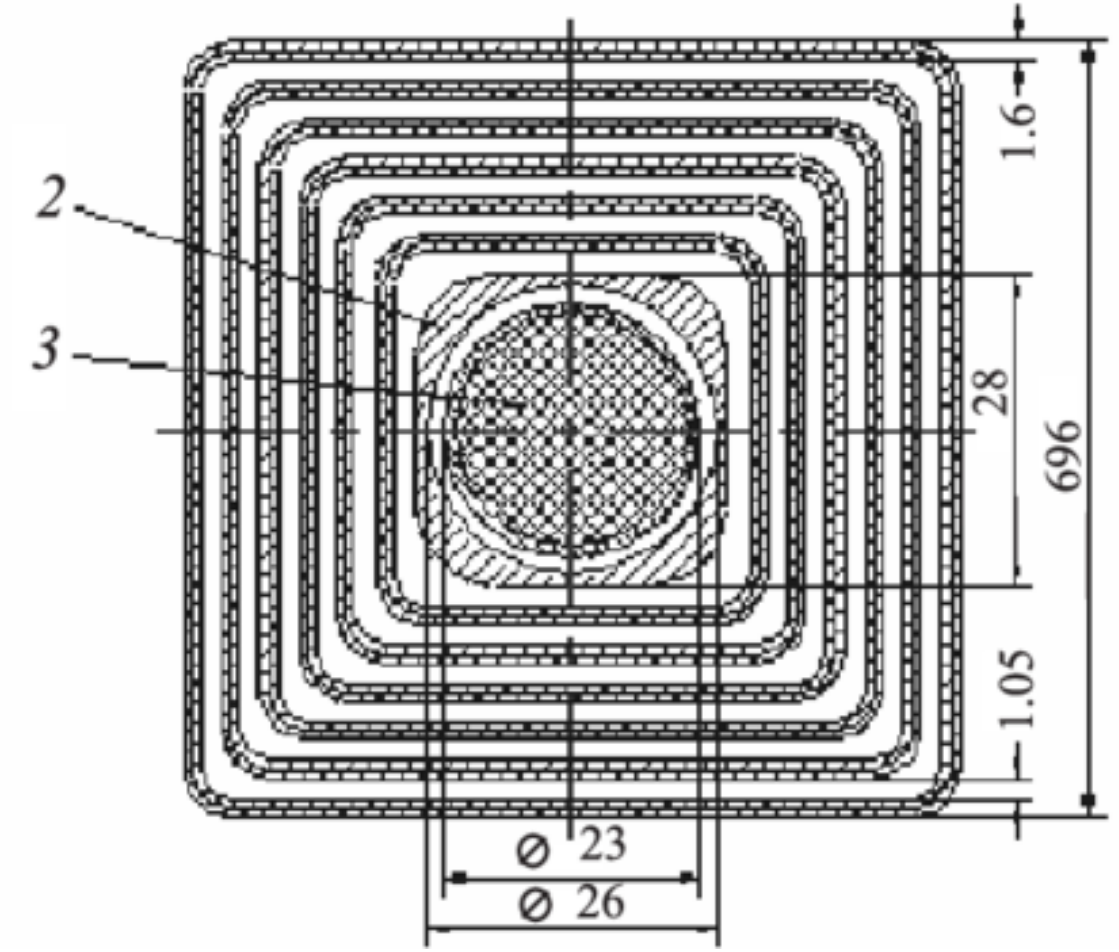
WWR-SM (cont.)

- Diameter: 682 mm;
- 20 fuel assemblies of IRT-4M.



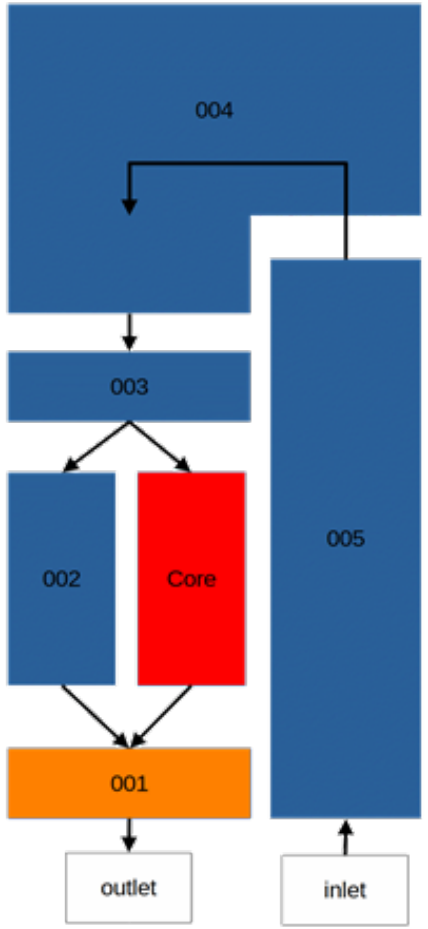
IRT-4M

- 6 coaxial square fuel plates with a 19.7% enrichment;
- Clad: Aluminum;
- Fuel meat: 600 mm.



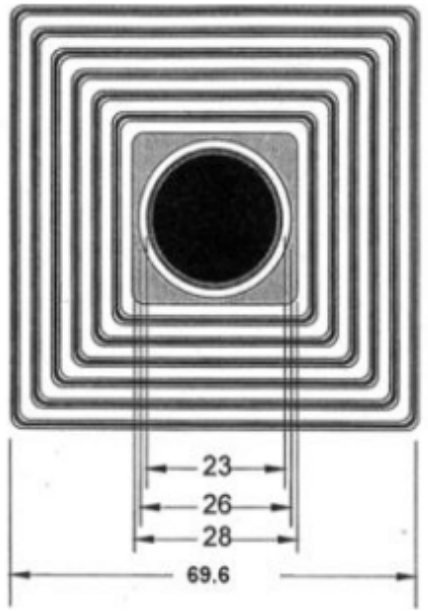
RELAP5 model

- Central tank: 001, 002, core, 003;
- Vessel core: 004, 005;
- Heat exchanger: simplified as inlet and outlet;
- Component *'core'*: 7-average channels, 7-average channels & 7-hot channels, 140 channels.



RELAP5 model (cont.)

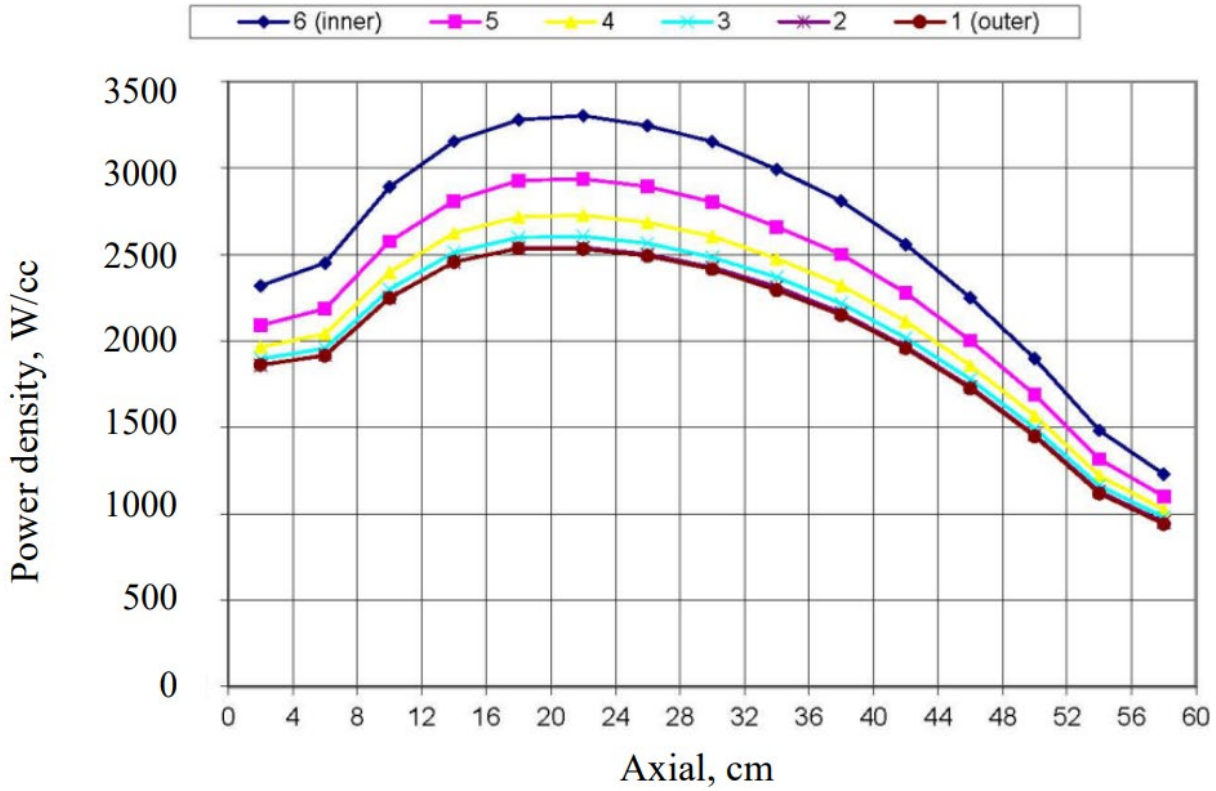
- Conversion of square tubes to circular rings;
- Square perimeters = circular perimeters.



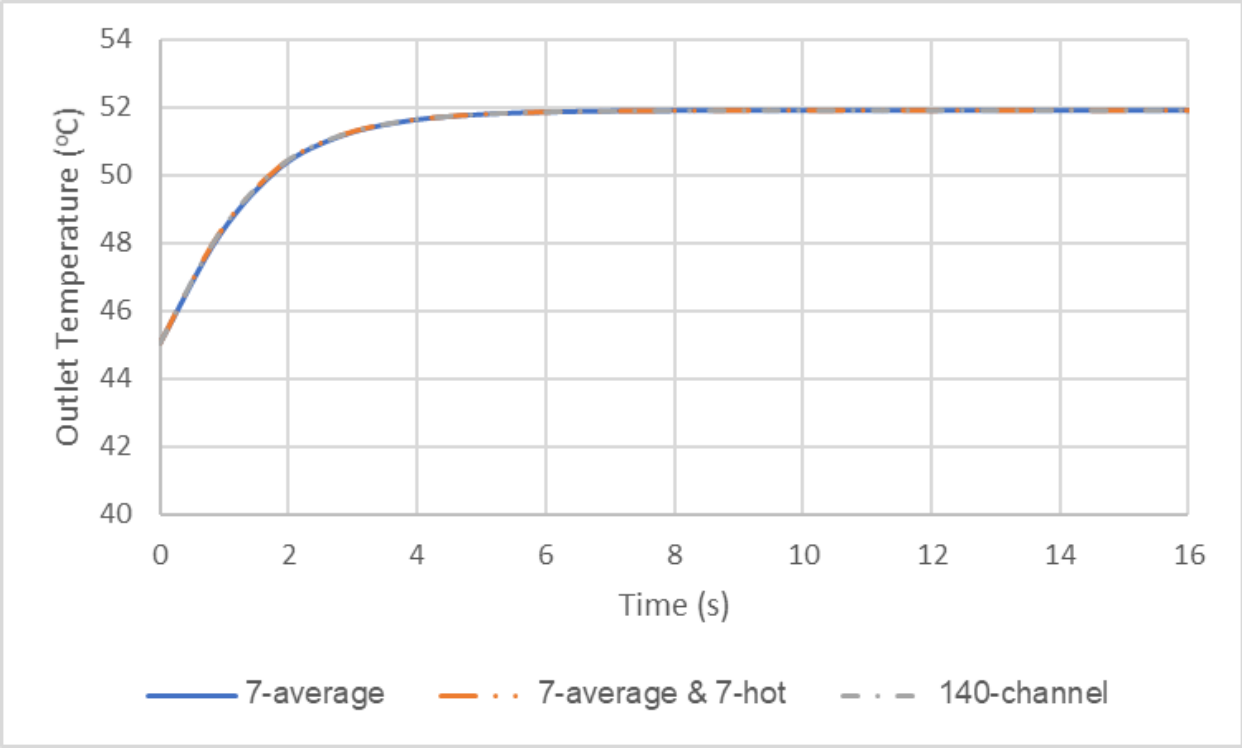
RELAP5 model (cont.)

Thermal power, %					
0.000	5.210	4.891	4.785	4.137	0.000
4.205	5.438	5.985	5.978	4.974	4.636
4.897	5.018	5.863	5.849	5.283	4.042
0.000	4.387	4.532	4.596	5.297	0.000

RELAP5 model (cont.)



Result

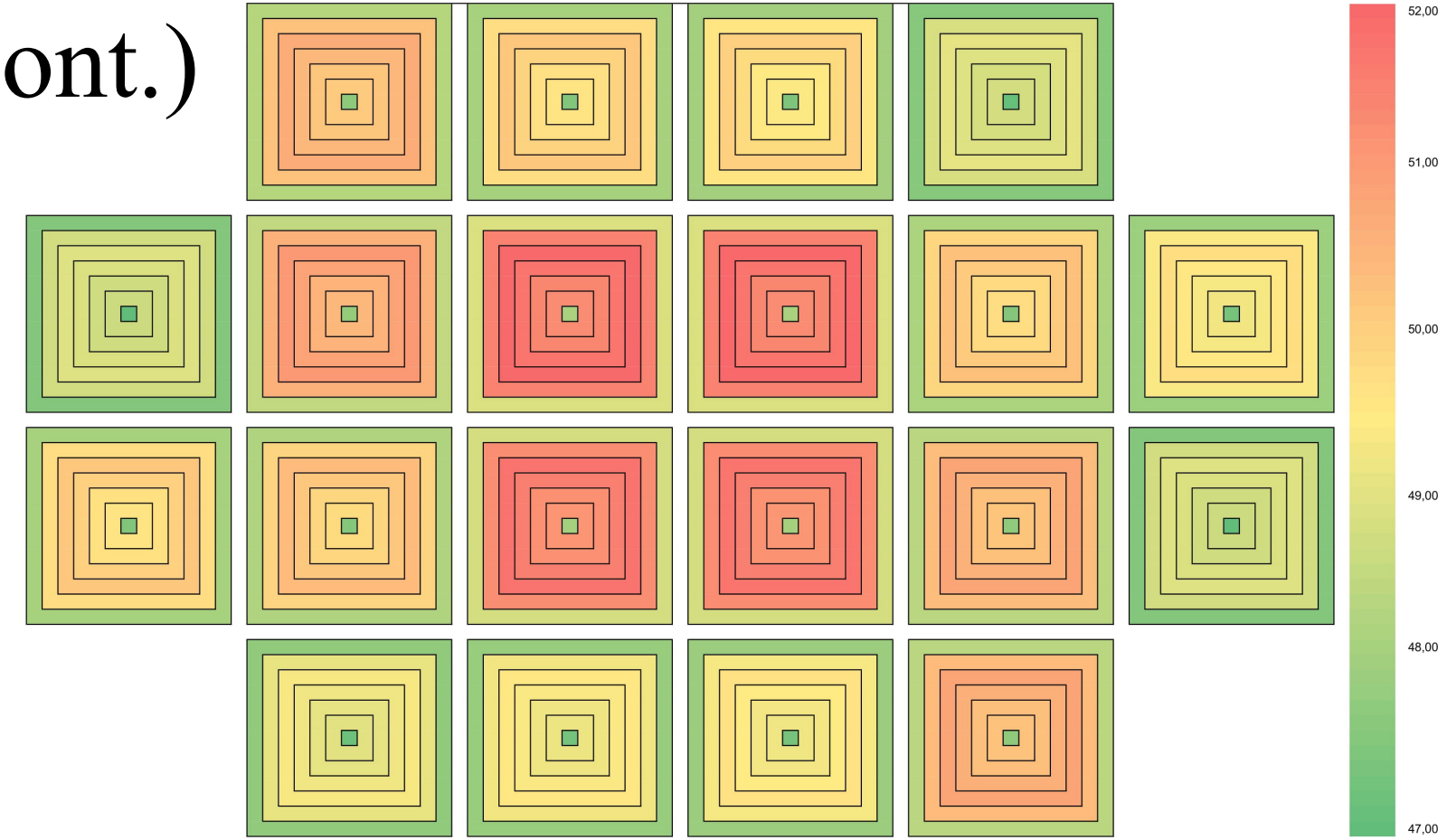


- Transient evolution of outlet temperature;
- Outlet temperature is consistent across model.

Result (cont.)

	Reference	7-average channels		7-average channels & 7-hot channels		140 channels	
		Steady state	Transient	Steady state	Transient	Steady state	Transient
Maximum cladding temperature (°C)	94,5	77.6	77.6	95.6	95.6	95.7	95.7
Cost (s)		6.2	11.0	12.6	21.6	672.0	1074.9

Result (cont.)



Reference

- Dien Nhi Nguyen, (2019), *ĐTĐL.CN-50/15*.
- A. L. Costa, P. A. L. Reis, C. Pereira, M. A. F. Veloso, A. Z. Mesquita, and H. V. Soares, “Thermal hydraulic analysis of the IPR-R1 TRIGA research reactor using a RELAP5 model”, *Nuclear Engineering and Design*, 1487–1494, 2010.
- Dalat Nuclear Research Institute, (2012), *Safety Analysis Report for the Dalat Nuclear Research Reactor*, Dalat Nuclear Research Institute, Vietnam.

Reference (cont.)

- IAEA, (2019), *Benchmarking against Experimental Data of Neutronics and Thermohydraulic Computational Methods and Tools for Operation and Safety Analysis of Research Reactors*, IAEA, Austria.
- I. D. Abdelrazek, E. H. Amin, M. Gaheen, and A. Gamal, (2019), *EGYPT'S BENCHMARK RESULTS AGAINST EXPERIMENTAL DATA FROM ETRR-2, RSG-GAS AND WWR-SM*, IAEA, Austria.
- I. D. Abdelrazek, M. NaguibAly, A. A. Badawi, Asmaa G. Abo Elnour, and A. A. El-Kafas, "Investigation of the Capability of REALP5 to Solve Complex Fuel Geometry", International Journal of Physical and Mathematical Sciences, 529 – 535, 2014.
- S. A. Baytelesov, F. R. Kungurov, and B. S. Yuldashev, "Thermal-hydraulic calculations of the WWR-SM research reactor", Nuclear Physics and Atomic Energy, 152 – 156, 2020.

Thank you!