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# THERMAL-HYDRAULIC CODES VALIDATION FOR SAFETY ANALYSIS OF NPPS WITH RBMK

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## Abstract

This work is devoted to validation of western thermal-hydraulic codes (RELAP5/MOD3.2 and ATHLET 1.1 Cycle C) in application to Russian designed light water reactors. Such validation is needed due to features of RBMK reactor design and thermal-hydraulics in comparison with PWR and BWR reactors, for which these codes were developed and validated. These validational studies are concluded with a comparison of calculation results of modeling with the thermal-hydraulics codes with the experiments performed earlier using the thermal-hydraulics test facilities with the experimental data.

## Methods

Leading experts of russian organizations erec, rrc ki, entec and relap5 code developers from ineel (usa) have developed a validation procedure and prepared general guidelines. A list of processes/phenomena was developed and each entry was assessed for two criteria: importance for safety of rbmk and degree of knowledge. Previous relap5 validation work was assessed for sufficiency. As a result of analysis of experimental data available in russia a prioritized list of potential standard problems was defined.

## Results

Validational studies have been performed for two standard problems from the list of potential standard problems. Independent review of the results was performed in russian and in the usa. The modeled tests are:

1. Countercurrent flow investigation with rrc ki experiment "stop of flow rate at the inlet to rbmk fuel channel when removing residual heat" performed at ks test facility.

The objective of the experiment was investigation of fuel assembly model cooling under condition of phases counter current flow.

2. Thermal hydraulic instability in parallel heated channels performed at erec 108 experimental test facility.

The objective of the experiments was to investigate the boundary of thermal hydraulics instability in parallel channels.

As a result of analysis of the first experiment, time periods between complete stop of flow and deteriorated heat exchange onset were determined.

Boundaries of thermal-hydraulics instability in dimensionless coordinates were obtained as a result of the second experiments.

## Discussion

The phenomena of counter current flow and counter current flow restriction were analyzed for different heat powers during analysis of the first standard problem. Counter current flow restriction was observed in different cross sections of the channel depending on the heat power.

The thermal hydraulic instability is characterized by flow rate oscillations. The flow rate oscillations are associated with variations of other thermal hydraulic parameters. Such oscillations may lead to critical heat flux conditions. To ensure safe operation of rbmk reactors it is necessary to know the range of parameters within which no thermal hydraulic instability occurs as well as methods to widen these ranges. Thermal-hydraulics instability boundaries for different geometry and mode parameters were obtained as a result of the analysis of the second problem disscussed.

Comparison of calculated results with experimental data was performed for the standard problems analyzed.

It is suggested to discuss the following questions as well:

1. Capabilities of large-scale integral thermal-hydraulics test facilities;
2. Capabilities of up-to-date thermal-hydraulics codes;
3. Computer thermal-hydraulics codes validation procedure;
4. Numerical methods of adequacy assessment of modeling with the code of particular phenomena or process.

## Conclusions

From the analyses the following conclusions were drawn:

1. Thermal-hydraulics codes relap5 and athlet in general are capable of modeling the processes and phenomena occurring in the selected tests;
2. For some tests under investigation, considerable disagreement between experimental data and calculational results is observed;
3. Experimental data available are of low quality, therefore for complete validation of thermal-hydraulics codes in application to rbmk new experiments with up-to-date thermal-hydraulics tests facilities are needed;
4. Numeric methods of adequacy assessment are required to make a final conclusion on adequacy of modeling with the code of the process or phenomena under investigation. These methods should be accepted by leading organizations in the field of npp safety.