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ANALYSIS WITH RELAP5 COMPUTER CODE OF EXPERIMENTS FOR INVESTIGATION OF VOID FRACTION DISTRIBUTION IN RBMK FUEL CHANNEL MODEL

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The work is part of an effort to validate computer code RELAP5/Mod3.2 in application to RBMK. Such validation is needed due to features of RBMK reactor design and thermal-hydraulics in comparison with PWR reactor for which this code was developed and validated.

The work was performed in frame of Joint Project #6 «Computer code validation for transient analysis of VVER and RBMK reactors» between US and Russian INSC.

Standard Problem for investigation of void fraction distribution in RBMK fuel channel for steady states was regarded as one of most important tasks to be performed within the project. To define the Standard Problem experimental data from BM test facility (NIKIET) were used.

Single experimental channel was used for the tests. The experimental channel is a model of RBMK fuel channel with volume-power scale 1:2.57. Elevation scale is 1:1. Heat release section includes FA model of 7 full scale fuel rods simulators. The simulators are electrically heated. Water is used as coolant. Experimental channel of the BM test facility differs from FC of RBMK reactor with FA of 18 rods and the central non heated rod, however there are no data of acceptable quality from full scale FC model.

Cross section average coolant density was measured with contactless neutron sensor. The sensor utilizes method of measurement of rate of registration of slow neutrons obtained from Pu-Be source of fast neutrons and passed through water. The sensor signal was processed with electronic frequency-meter. Void fraction was calculated from density measured in the considered cross section, pressure measured in the outlet of the heated section and temperature measured in the inlet of the heated section.

Different steady states of reactor were modeled in the tests. Void fraction was measured at 10 cross sections of fuel channel for each steady state.

Validation with calculations based on the experimental data was performed. Total 25 steady states were analyzed differing with flow rate and water temperature in the inlet of experimental channel, pressure in outlet of the experimental channel and heat power of the FA model. Reasonable agreement between calculations and experiments was achieved.

Sensitivity studies were carried out as follows.

1) Different of hydraulic diameters of the heat release section and calculation applying a homogeneous model of the flow in the heat release section were used to estimate the influence of calculation accuracy of interphase drag on the results.

2) To estimate the influence of accuracy of heat transfer coefficient determination at subcooled water boiling on the results, the calculations were performed at varying value of coefficient used in heat transfer correlation.

3) Calculations were performed to evaluate the influence of the heat losses on the void fraction distribution over the height of the heated section.

4) Calculations were carried out to estimate influence of the pressure measurement location on the accuracy of the void fraction calculation from the coolant density been measured. The values of void fraction were determined directly from RELAP5 variable “voidg” and from RELAP5 variables for density (“rho”) according to procedure used in tests.

5) An assessment of influence of calculation accuracy of pressure losses due to wall friction on the calculation results of void fraction distribution over the height of the heated section was performed.

6) Change of the electrical resistance along the length of the rod simulator leads to the non-uniform profile of heat release. Therefore the influence of the rod simulator temperature on the specific resistance was estimated.

7) Axial heat transfer due to difference in temperature along the rod simulator may cause non uniformity of rod heat release. To estimate impact of assumption of no axial heat transfer axial heat flux was calculated for subcooled segment of the FA simulator.