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THE 2-nd STANDARD PROBLEM OF VVER REFLOODING: BASIC RESULTS

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ABSTRACT

The computational assessment of reactor core component behavior under accident conditions is impossible without knowledge the thermal hydraulics of processes occurring in this case. The thermal hydraulic computer codes applied for this purpose are therefore the one of key tools of the nuclear plant safety analysis. The adequacy of the results obtained by these computer codes to the processes being analyzed is checked by carrying out a number of Standard problems.

At the last Forum-2000, the results of performance of the 1-st Standard problem (SP-1) on VVER reflooding: "VVER 7-rod bundle model cool-down at bottom reflooding" have been presented. In the same year, the activity began on the performance of the 2-nd Standard problem (SP-2) on VVER bottom reflooding by using the experiment on full height 37-rod bundle model cool-down. The representatives from the eight MINATOM's organizations took part in this work, in the course of which the evaluations were performed using both the Russian computer codes (KANAL-97, KORSAR) and the foreign computer codes (RELAP5, ATHLET, CATHARE, COBRA-TF).

The paper presents the description and the basic results of computational analysis of the experiment proposed as the Standard problem.

The comparison of calculational results with the experimental data showed the following.

The stage of rod bundle heating up and integral process characteristics (water and steam carry-out from rod bundle) are quite fairly predicted by the computer codes.

Most computer codes give the calculated values of peak rod temperature exceeding the experimental ones; the level of calculation conservatism not exceeding 10% of peak temperature value. The largest underestimation of peak rod temperature as compared to the experiment was obtained in the calculation according to the RELAP5/Mod3.2 code; however, it is only about 5% in this case too.

Only three calculations produced lower values for the full time of bundle cool-down than the experimental ones. Other calculations produced the conservative values of this quantity.

The best results in prediction of absolute peak rod temperature and bundle cool-down time were obtained by the calculations according to the KORSAR, KANAL-97, RELAP/5Mod3.2 computer codes.

In addition to these “integral” characteristics, the calculated curves of time variation of relative rod temperature maximum and the location of rewetting front were compared with the experiment. This comparison showed that the most disagreement between the calculated results and the experimental ones is observed in the upper part of rod bundle, and it is, in general, due to the random nature of formation of secondary quenching fronts in the experiment.

The calculations by means of the same versions of the RELAP5 code, performed in different organizations, made it possible to assess the “user effect”. The analysis of calculations showed that the experience gained by designers in performing the SP-1 as well as a more simple (from the viewpoint of computational simulation) statement of the SP-2 (no non-heated rods in bundle) resulted in the decreasing this effect. Thus, the SP-1 calculation results by the RELAP5/Mod3.2 code, that had a rather large discrepancy, disagree in the SP-2 case much less, and the calculation results by the RELAP5/Mod3.2.2 code approached each other noticeably too.

The results of this Standard problem performance may be used to verify the existing thermal hydraulic computer codes and those being developed as well as to certify the latters by supervision bodies.