

ϵ_{TIN} = maximum relative error in measuring the coolant temperature at the channel inlet

A, B, C = upper scale values of the instruments for measuring flow, pressure, and temperature, respectively.

When speaking about the margin to critical RBMK power, it is usually meant that the coefficient η is equal to ~ 1 .

If we turn to determining the margin to critical power for BWRs, i.e., to calculating the ratio of the critical fuel assembly power to its maximum allowable operating value, or equivalently, to assessing the expression

$$3(D_N N_c^2 + D_{Nch} N_{ch}^2)^{1/2},$$

we get almost the same value as that for BWRs:

$$\frac{N_c}{N_{ch}} = 1.2.$$

The correlation for the critical power of RBMK fuel assemblies, based on the averaged coolant parameters, was obtained from electrically heated fuel assembly models in the region of the corresponding regime parameters and was verified by in-pile tests.

The expression for N_c given in Ref. 1 has some mistakes. Its proper form is

$$N_c = \frac{4.28 \times 10^6 D_H^{0.83} (G_{ch} 10^{-3})^{0.57} + 4.07 D_H G_{ch} \partial_H F}{664 D_H^{0.57} (G_{ch} 10^{-3})^{0.18} + 39.4 L}.$$

A few words should be said about using subchannel analysis techniques. Application of these techniques for the analysis of thermal and hydraulic parameters of fuel assemblies would be extremely useful, particularly at the design stage, although the empirical relations describing flow hydraulics in subchannels and the very correlations for calculating the critical conditions in subchannels call for thorough experimental verification. Besides, these techniques can undoubtedly be helpful in assessing the correctness of extending the model research results to real fuel assemblies, while there is usually no full similarity between them, as well as in studying the sensitivity of the critical margin to changes in the design parameters.

The local thermal-hydraulic performance of RBMK fuel assemblies was analyzed using the ЛУЧОК code. Calculations by this code for test experiments showed satisfactory agreement with those based on the COBRA code and are presented in Ref. 2.

Comparison of the power calculated by local characteristics with the experimental critical power for a 19-rod fuel assembly model shows a 10% spread in the results, depending on the relative inlet enthalpy.

The GE and other CHF correlations used for local subchannels offer more optimistic results, but it should be borne in mind that they were obtained for fuel assemblies with geometries that are different from that of RBMK assemblies. This is, perhaps, the reason for the optimistic judgments about some correlations in Ref. 1.

Therefore, the data from our analysis of local fuel assembly parameters do not allow us to be too optimistic about the margins for critical heat loads. The calculations were made using the CHF correlations best suited for describing the lo-

cal subchannels of RBMK fuel assemblies.^{3,4} The CHF margin in the form of the heat flux ratio in the subchannels with the highest heat flux amounted to no less than 1.5.

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RESPONSE TO "COMMENTS ON 'OPERATING MARGIN OF SOVIET RBMK-1000 NUCLEAR POWER REACTORS' "

It was with great interest that we read Ref. 1 regarding our recent paper.² We would like to apologize for the error in reporting the form of the RBMK critical power in our paper. We did, in fact, use the proper form of this correlation, as provided in Ref. 1, in our calculations; however, we inadvertently recorded an incorrect form during the drafting of our manuscript that continued into the final paper.

We were interested to learn that the critical power calculation for RBMK reactors proceeds by way of additional refinements to the channel critical power; that is to say, the channel critical power represents an input parameter to a higher level equation that includes other uncertainties not included in the correlation. We were unable to find any reference to this methodology in the sources that we had available to us. The calculations for the channel critical power that we did perform were in agreement with those reported by Dollezhal and Emel'yanov, who quoted critical heat flux (CHF) margins of 1 to 25%. These are also consistent with the 38% CHF margin calculated by the independent review of the RBMK design by the Central Electricity Generating

Board (CEGB). Use of the local CHF correlations indicated larger margins than those quoted from these sources.

Reference 1 correctly points out that the geometrical differences between the RBMK fuel assembly and the test rigs on which the various local CHF correlations were obtained may account for these differences, but as we endeavored to point out, the RBMK fuel assembly parameters did, for the most part, fall within the range of applicability of the correlations employed.

As indicated in Ref. 1, the RBMK design practice also includes other operational and instrumentation uncertainties that must be included when determining the true CHF margin. This information is not available to us, but would decrease the available CHF margin. This is similar to current pressurized water reactor practice where a 7% margin is retained for plant instrumentation and power uncertainties and a 23% margin is retained for correlation uncertainty such that the minimum CHF (or departure from nucleate boiling) ratio is 1.3. If we had values for the other uncertainties, they could be combined with the calculated local CHF value to obtain a more accurate estimate of the true CHF margin for the RBMK. It is believed that the resulting true CHF margin

would be closer to the values quoted by Dollezhal and Emel'yanov and the CEGB report.

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