REFEREE REPORT

on the PhD thesis *A time-dependent formulation of the HEXNEM3 nodal method for solving the neutron transport equation in diffusion approximation* in the professional field 4.1 "Physical Sciences presented by Srebrin Toshkov Kolev

by the member of the scientific jury Prof. Roumen Vassilev Tsenov, Dr.Sci. from the Department of Atomic Physics, Sofia University "St. Kliment Ohridski"

The thesis is dedicated to the creation and verification of a new formulation of the large-cell nodal method HEXNEM3 (developed earlier by other authors, including the PhD student's supervisor) for computation of neutron propagation in the core of a nuclear power reactor and, specifically, for solving non-stationary problems. The fuel cell in the reactor core, which has relatively large transverse dimensions (eg 23.7 cm for WWER-1000), is chosen as a node. This requires a "homogenized" representation of the neutron fluence inside the fuel cell and formulation of specific boundary conditions on its surface. The division of the neutron flux into two energy groups (the dividing boundary is chosen to be 0.625 eV) leads to a need to iterate solutions over these groups. One of the new things and advantages of the proposed formulation of the above method is that it avoids this iterative procedure by separating of the transfer equations over the dependent quantities and obtaining a system of such equations for each quantity to be computed (mod). In addition, the proposed program implementation is much more economical in terms of computing resources than the codes used so far.

Related to the above, I have two questions:
• what determines the energy splitting of the neutron flux into only two groups and why is this specific value of the energy boundary chosen? Would the accuracy of the method be improved if the neutrons were grouped into more energy groups?
• what justifies the development of large-cell nodal methods, where the node is the fuel cassette, since there are more accurate fine-cell methods for solving the transfer equations, where the node is the reactor pin with an order of magnitude smaller transverse size, e.g. 1,275 cm for WWER-1000? Nowadays computers could be as powerful as needed so that each reactor could be equipped with as powerful a computer as we want, which could solve transfer problems with predetermined accuracy and in affordable time. The addition of such a computer would lead to a negligible increase in the cost of the energy complex.

Finally, I would like to note that the thesis is an independent and complete research work. The nodal method HEXNEM3 for solving the problem of neutron transfer in the core of a nuclear energy reactor has been significantly improved. A software

implementation has been created that achieves good convergence and numerical stability while providing the same or better accuracy compared to existing codes. The results have been published in peer-reviewed journals with impact factor or impact index and have been reported in scientific forums. In all publications the author has a leading contribution (the author's team consists of two people and Srebrin Kolev is in the first place).

CONCLUSION: After getting acquainted with the thesis and the extended abstract, I confirm that they meet the requirements of the Law on the Development of Academic Staff in the Republic of Bulgaria for the award of scientific and educational degree "Doctor", the regulations of the Council of Ministers and Sofia University "St. Kliment Ohridski" for its application, as well as of the *Additional requirements to the candidates for acquiring scientific degrees in the Faculty of Physics of Sofia University in direction 4.1. Physical Sciences* and that their author Srebrin Toshkov Kolev undoubtedly deserves award of the scientific and educational degree "Doctor" of the Sofia University "St. Kliment Ohridski" in the field "Physical Sciences".

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Sofia (Prof. Roumen Tsenov, Dr.Sci.)