SIMULATING COUPLED NEUTRON-FLUID-HEAT TRANSFER FOR THE STUDY OF UNINTENDED OPERATING SCENARIOS IN PRESSURE WATER REACTORS USING AN IMMERSED BODY MODELLING TECHNIQUE

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ABSTRACT

This article presents a new approach for the efficient simulation of the transient, multiphysics processes in complete 3D nuclear reactor core problems. It applies a recently developed immersed body submodel method that enables the physics of neutron transport, fluid flows, fluid-solid interactions and heat transfer to be coupled together within a computationally efficient framework. The novelty of this article is that this is the first time such a method has been used in the prediction of such large scale reactor physics problems. The method allows the study of full transient core responses following an asymmetric reactivity perturbation. To demonstrate the model a hypothetical problem has been proposed, which is then resolved using this method. This problem is a blend of current OECD benchmark problems with minor modifications to allow the study of core perturbations. In this example the response to a localised cold slug ejection of coolant is studied. The immersed body submodel method was found to be capable of capturing the underlying physics of the problem and yielded a number of interesting features that would not necessarily be highlighted by typical courser mesh systems codes without supplementary subchannel analysis.