Foreword

Special Issue on the RELAP5-3D Computer Code

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Guest Editor

This issue of *Nuclear Science and Engineering* is dedicated to RELAP5-3D, the nuclear power plant safety computer code available from Idaho National Laboratory (INL) of the U.S. Department of Energy. The papers in this issue represent a sampling of some of the recent advancements in verification, validation, theory, and code capability of RELAP5 and future directions of research, development, and application of the code.

The issue begins with papers that focus on verification and validation (V&V) and theory. The first paper presents a rigorous method for code verification that could be applied to numerous engineering and physics codes. Statistical theory shows the extreme accuracy of this automated method applied on a comprehensive test suite for finding changes in calculations. The second paper provides a methodology for performing both V&V and uncertainty evaluation on best-estimate codes, such as RELAP5-3D, with particular application to licensing.

Next, the third paper applies Fourier stability analysis of the two-phase system of field equations to develop new hyperbolicity criteria. These are successfully applied to attain marked gains in stability with minimal effect on code calculations. The fourth paper derives the two-phase, six-field balance equations that will be implemented in RELAP5-3D to better model large and small bubbles and droplets along with the continuous liquid and vapor fields for better overall modeling of the thermal hydraulics inside nuclear power plants.

The latter half of this special issue presents recent developments in RELAP5-3D code capabilities. Applications of these new capabilities are presented. In many cases, the application of these new capabilities is far reaching and will lead to new uses of the code in fields other than nuclear. The fifth paper in this issue presents the theory, design considerations, development, and usage of variable gravity for modeling moving systems. Thus, RELAP5-3D is capable of modeling reactors aboard moving ships, aircraft, and spacecraft as well as land-based reactors during earthquake conditions. The sixth paper explains the implementation of the Moody homogeneous equilibrium critical flow model in RELAP5-3D and assesses it.

Major advances have been made in combining RELAP5-3D with other computer codes to solve more complex problems via domain decomposition, assigning each program the portion of the calculation to which it is best suited and exchanging data as needed to advance the solution. Exchanges are made in several ways, including direct memory-to-memory data exchange and exchanges through sockets. The seventh paper in this issue presents a coupling of RELAP5-3D with the neutronics code PHISICS, which takes advantage of cluster supercomputer architecture to model neutron kinetics in great detail. The eighth paper presents a coupling of RELAP5-3D with LabVIEW for directly inputting data from experiments, which allows greater flexibility in configuring alternate components and calculations matched to particular hardware.

This collection of papers provides a representative sampling of the ongoing work with RELAP5-3D at INL and many other institutions in conjunction with the International RELAP5 Users Group. We hope that you find these papers valuable and interesting.

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