Foreword

Special Issue on the RELAP5-3D Computer Code

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Guest Editor

This issue of *Nuclear Technology* 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 (DOE). The papers in this issue represent a sampling of the code's many applications today and some of its potential for the future.

The issue begins with papers that focus on modeling various power plants, including a high-temperature gas-cooled reactor, liquid metal reactor, VVER (water-water energetic reactor), and various other pressurized water reactors with light and heavy water coolant and moderator, as well as boiling water reactors (BWRs). Following these are papers that pertain to the very important field of licensing nuclear power plants and to the application of RELAP5-3D in licensing. The issue then concludes with papers that introduce new methods for using the code, from coupling with other programs to solve even more complex problems, to means of building input models and analyzing series of runs, to user aids.

The three-dimensional capabilities of RELAP5-3D are demonstrated from the outset. The first paper in this issue validates the three-dimensional thermal-hydraulics approach against a particular experiment. The second paper benchmarks the three-dimensional neutronics available through the combined RELAP5-3D/PHISICS (Parallel and Highly Innovative Simulation for INL Code System) software. Skipping the third paper for now, the fourth paper demonstrates another three-dimensional neutronics capability in RELAP5-3D: the fully-integrated NESTLE program.

These first papers also present code validation against experimental data from separate and integral effects tests, from plants, and against other computer programs. Equally important is the construction of good plant models. The fourth paper in the issue presents means to qualify code calculations to determine if the nodalization and geometric and thermal-hydraulic parameters of the input model have sufficient fidelity.

With a validated code and qualifying model, RELAP5-3D can be used in the design process for nuclear plants. The third paper in this issue presents the use of the code for the MYRRHA (Multi-purpose hYbrid Research Reactor for High-tech Applications) plant, and the fifth paper applies RELAP5-3D to study designs that improve core coolability during a loss-of-coolant accident.

The second set of papers concerns the use of RELAP5-3D in U.S. Nuclear Regulatory Commission licensing. The sixth paper presents a philosophical and mathematical viewpoint of knowledge-base and decision-making methodology then applies it to RELAP5-3D analysis for regulatory deliberations. The seventh paper outlines key aspects of the best-estimate plus uncertainty process aimed at licensing the Atucha-II nuclear power plant pressurized heavy water reactor. This includes the adequacy of the selected spectrum of events and the availability of qualified tools and analytical procedures, particularly the method of modeling with RELAP5-3D. The eighth paper applies risk-informed safety margin characterization to provide insights to decision makers about a BWR uprate through stochastic analysis of a series of station blackout simulations with varying initial conditions as calculated by RELAP5-3D coupled with INL's RAVEN software. The ninth paper presents RELAP5-3D analysis of an important rod ejection scenario for a Russian VVER.

The third broad topic covered by papers in this issue regards developments for analysts that provide new or improved means of using RELAP5-3D. The tenth paper explains the development of the code-coupling technology that allows RELAP5-3D to combine with other codes to solve more complex problems through domain decomposition, giving the portion of the domain to which each code is best suited to that program. For example, RELAP5-3D may model the bulk of the plant and combine with a computational fluid dynamics code that performs detailed analysis of the lower plenum or core, as well as an instrumentationand-controls program and a containment program. This technology represents a step forward in the ability to model complex systems through code combination.

The eleventh paper presents a graphical user interface for editing RELAP5-3D input models, developing simulation suites with Quality Program records required for the U.S. Code of Federal Regulations 10 CFR 50 Appendix B, preparing analyses of uncertainty and sensitivity/importance, executing on remote servers, plotting, and data checking against the modeling rules. This issue concludes with a technical note about two useful tools, RELAP5-3D Graphical User Interface and Pygmalion, for creating a new input deck from the steady-stated output file of an original input model.

RELAP5-3D has a large international body of users that includes all members of the International RELAP5 Users Group (IRUG). Additional information is available at www.inl.gov/relap5/. The RELAP5-3D code is under continuous development to meet the needs of the nuclear industry. IRUG membership fees are used to maintain RELAP5-3D, stay abreast of advances in the computer industry, correct issues as users report them, improve modeling capabilities, and perform verification and validation before code releases. This reinvestment of membership fees allows RELAP5-3D to remain the state-of-the-art safety analysis tool for nuclear power plant safety analysis.

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