Foreword

Special Issue Featuring Papers from the 2024 Advanced Reactor Safety Topical Meeting (ARS 2024)

Guest Editor

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It is my pleasure to welcome readers to this special issue of *Nuclear Technology*, featuring selected papers from the American Nuclear Society (ANS) Advanced Reactor Safety (ARS) Topical Meeting held in Las Vegas, Nevada, June 16–19, 2024. This collection captures the state of the art in advanced reactor safety—spanning hazard identification, accident phenomenology, source-term behavior, risk assessment, and enabling technologies that support safe design, operation, and licensing of next-generation systems. It also marks the revival of a proud ANS Nuclear Installations Safety Division (NISD) tradition, as the 2024 meeting restarts a topical series central to our community's technical dialogue.

From 1994 through 2012, the ARS conferences—organized by the ANS NISD—together with the International Conference on Probabilistic Safety Assessment and Analysis (PSA) were held deliberately in alternating years to provide complementary forums. ARS emphasized design innovation, coolant chemistry and materials interactions, severe-accident understanding, and safety analysis for advanced concepts, while PSA expanded the rigor and application of probabilistic methods that risk-inform decisions. Together, they shaped today's risk-informed safety culture, catalyzed progress in passive safety and beyond-design-basis analyses, and seeded many of the tools and datasets we rely on. After a pause, the 2024 Las Vegas conference reopened this channel at a pivotal moment—when multiple advanced reactor designs are transitioning from concept to deployment and when regulatory modernization increasingly calls for integrated deterministic and probabilistic evidence.

The papers assembled in this special issue reflect that integrated perspective. A literature review of preliminary initiating events for a gas-cooled fast reactor provides a structured foundation for early-phase safety analysis. Operational and life-cycle considerations advance through a batch refueling framework that implements the so-called Sourdough fuel cycle and waste management strategy in a novel molten salt reactor design. Practical chemistry control is enabled by the development and demonstration of a prototype molten salt sampling system. Accident progression and source-term mitigation are examined in several contributions: investigating the role of chromium-coated cladding during small modular reactor events; assessing the iodine gas decontamination in sodium pools to quantify attenuation mechanisms; and developing a salt-spills methodology in molten salt reactors to examine two-phase mechanical aerosolization and evaporation mass transfer. Complementing these phenomenological studies, a systematic diagnostics and enhancement framework for probabilistic risk assessment tools advances computational capabilities to support the development of more advanced Boolean evaluation methods. Collectively, these works point to clear trends: tighter coupling of materials and coolant chemistry with safety analysis, experimentally anchored models for non-water coolants, and probabilistic risk assessment capabilities that are fast and accurate to support risk-informed decisions in near real time.

This special issue reflects the dedication of many. We thank the authors for their high-quality submissions and timely revisions; the reviewers for rigorous, constructive evaluations; the session chairs, technical program committee, and conference organizers for curating an exceptional program; and the ANS publication staff for their professional stewardship. We invite readers to continue the conversation at the next ANS ARS conference, to be embedded in the 2026 ANS Winter Conference and Expo, November 15–18, 2026, in Phoenix, Arizona, at the Arizona Grand Resort &

Spa. We look forward to seeing you there and to the progress our community will continue to deliver in support of reliable, clean energy and enduring public safety.

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