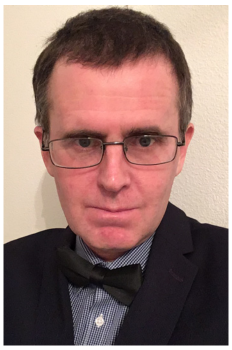
Journal of Nuclear Engineering and Radiation Science

Guest Editorial

Special Issue: EU ESFR-SMART Project
Word From the Horizon: 2020 EU ESFR-SMART Project Coordinator



Konstantin Mikityuk

This Special Issue of the ASME *Journal of Nuclear Engineering and Radiation Science* includes 2 editorials and 25 technical papers presenting the main achievements of the Horizon-2020 European Union ESFR-SMART project (European Sodium Fast Reactor Safety Measures Assessment and Research Tools) supported by the EURATOM grant and launched in September 2017. ESFR-SMART gathers a consortium of 19 organizations (see Fig. 1): research centers, industries, universities, technical and scientific support organizations as well as small to medium enterprise aiming at enhancing further the safety of Generation-IV Sodium Fast Reactors (SFRs) and, in particular, of the commercial-size European Sodium Fast Reactor (ESFR) in accordance with the European Sustainable Nuclear Industrial Initiative (ESNII) roadmap.

Project objectives

The project aims at five specific objectives:

(1) Produce new experimental data to support calibration and validation of the computational tools for each defense-in-depth level.
(2) Test and qualify new instrumentations to support their utilization in the reactor protection system.
(3) Perform further calibration and validation of the computational tools for each defense-in-depth level to support safety assessments of Generation-IV SFRs, using the data produced in the project as well as selected legacy data.
(4) Select, implement and assess new safety measures for the commercial-size ESFR, using the Generation-IV International Forum (GIF) methodologies, the FP7 Collaborative Project (CP)-ESFR project legacy, the calibrated and validated codes, and being in accordance with the update of the European and international safety frameworks taking into account the Fukushima accident. And
(5) Strengthen and link together new networks, in particular, the network of the European sodium facilities and the network of the European students working on the SFR technology.

Project and Special Issue structures

ESFR-SMART is structured in twelve work packages (WPs) grouped in three subprojects (SP) as clarified in Fig. 2. The first two SPs comprise five technical WPs each, while the third SP deals with dissemination, education, and training as well as project management.

The Special Issue reflects the project's structure but is in no specific order.

Introduction

The Guest Editorial by Dr. Joel Guidez presents some background of the project, including SFR history and prospects in Europe and the world as well as the ESFR-SMART position in this overall picture.

New safety measures

The paper by Ehster et al. presents the use of an objective provision tree method for formulating safety guidelines on defining and studying ESFR innovative design options at the preconceptual

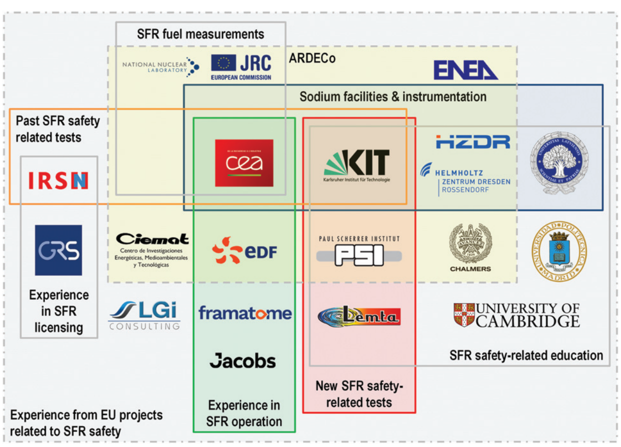


Fig. 1 ESFR-SMART partners: areas of expertise related to the project

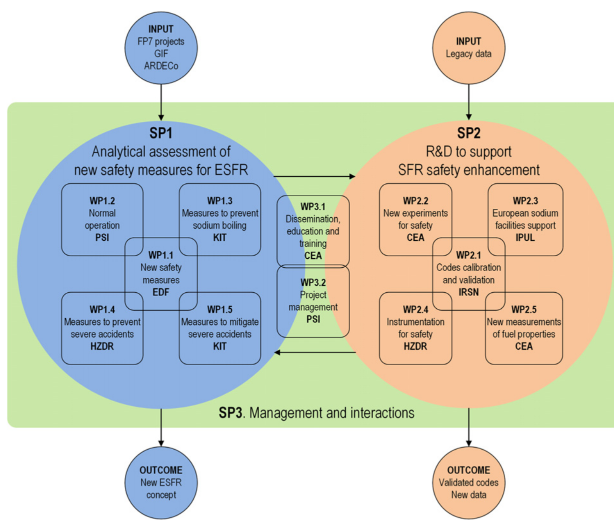


Fig. 2 Organizational structure of the ESFR-SMART project, showing the relationship between the work packages as well as the main input information and the main outcomes of the project

phase. The two papers by Guidez et al. present new reactor safety measures for ESFR in two parts: Part I for conceptual design and Part II for preliminary assessment. These two papers mainly relate to the system design, while the paper by Rineiski et al. focuses on the new core safety measures and their preliminary assessment.

Normal operation

A more detailed neutronic analysis is discussed in the two papers by Fridman et al., one on fresh core results and the other on burnup results. In addition to these "neutronics" papers, the paper by Lavarenne et al. presents an exercise on modeling of mixed uranium-plutonium Oxide (MOX) fuel base irradiation and, in particular, on the characterization of fuel-to-clad gap conductance, while the paper by Bodi et al. presents coupled neutronics-mechanics analysis aiming to evaluate reactivity changes due to the SFR-core distortions. The spatial distributions of reactivity coefficients at the end of the equilibrium cycle are evaluated in the paper by Baker et al.

Measures to prevent sodium boiling

The decay heat in ESFR is characterized in the paper by Jiménez-Carrascosa et al. while the paper by Bodi et al. analyses performance of decay-heat removal systems in transient conditions of protected station blackout. The performance of the reactor passive shutdown system in ESFR is evaluated in a paper by Bubelis et al.

Codes calibration and validation

Modeling of reactivity effects and transient behavior of large SFR using the Superphenix core as an example is discussed in the paper by Ponomarev et al. Two other papers by Ponomarev et al. describe a Superphenix benchmark (specification, reference solutions and solutions of selected codes) developed in the frame of the project. One paper focuses on static neutronics, while the second paper focuses on transient startup tests. The paper by Tsige-Tamirat et al. reviews models for sodium boiling phenomena, while the paper by Perez-Martin et al. evaluates predictions of selected sodium boiling models using KNS-37 (Kompakter Natrium Siedekreislauf) loss-of-flow experiments.

New experiments for safety

Another block of papers relates to experimental activities and calculational support of experiments. The block starts with a review of European experiments and codes to support safety assessments for SFRs by Hering et al. Ablation of a solid material by impingement of a high-temperature liquid jet is studied using hot liquid water impinging on a transparent ice block in the paper by Lecoanet et al. The Jamond et al. paper reassesses computational tools for modeling heat transfer in a molten uranium-dioxide pool in natural convection. The last two papers in this block present computational fluid dynamics (CFD) modeling results: CFD modeling of thermal ablation during corium-alumina interaction is presented by Czarny et al. while the paper by Grah et al. presents CFD analysis of the ESFR reactor-pit cooling system in case of sodium leakage.

New instrumentation for safety

A measurement technique based on eddy current flow meter (ECFM) was the focus of the project and paper by Krauter et al., which presents the performance of ECFM in liquid-metal flows inclined to the sensor axis, while simulation studies of the sodium hydraulic behavior to design a mockup for ECFM testing are detailed in the Delacroix et al. in paper.

Optimization for better economics

The final paper to mention in this Special Issue is by Guidez et al., which makes a step beyond the project by discussing optimization of the ESFR secondary loop.

In the end, I wish to thank all authors, NERS associate editors, reviewers, and, especially, Dr. Igor Pioro, Editor, who made this Special Issue possible.

Konstantin Mikityuk
Division Scientific Computing, Theory and Data,
Paul Scherrer Institute,
Villigen PSI 5232, Switzerland