ENERGETICS

MUR DM 117/Westinghouse - Advanced Uncertainty Quantification and Propagation Analysis to Support Lead Fast Reactor Development

Funded By	MINISTERO DELL'UNIVERSITA' E DELLA RICERCA [P.iva/CF:97429780584] Politecnico di TORINO [P.iva/CF:00518460019] Westinghouse Electrique France SAS [P.iva/CF:00206189995]

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Context of the research activity	Westinghouse is engaged in the development of a Lead-cooled Fast Reactor (LFR) design to support the decarbonization mission with improved safety and economic performance. The exploitation of LFR technology requires R&D efforts in different fields: this PhD project aims at performing Uncertainty Quantification and Propagation (UQ&P) studies on the multiphysics model of the Westinghouse LFR design. Progetto finanziato nell'ambito del PNRR – DM 117/2023 - CUP E14D23001950004

	The Westinghouse Lead-cooled Fast Reactor (LFR) is a 450 MWe class, lead-cooled, fast neutron spectrum, pool-type reactor being developed by Westinghouse in collaboration with global organizations. Its mission is to achieve a superior level of safety and economic performances while aiming at enhanced application versatility in support of deep decarbonization missions, and with the capability to close the fuel cycle by greatly improving use of uranium resources and minimizing long-term radioactivity of nuclear waste to be disposed. All this while exploiting liquid lead's inherent favorable properties and ad-hoc design solutions to reduce front-end capital cost and generate flexible and cost-competitive electricity. One of the crucial areas to progress the Westinghouse LFR design and safety case for future licensing and commercialization regards Uncertainty Quantification and Propagation (UQ&P) analysis. In comparison to conventional water-cooled reactors, there is no operational experience and

Objectives	thus relevant experimental data to be used for uncertainty assessment and establishment of safety margins for the Westinghouse LFR. The NEMO group staff at the Energy Department at Politecnico di Torino active in the field of LFR technology have developed, along the years, a significant expertise in the Multiphysics modelling of liquid-metal cooled fast reactors and in computational tools for the evaluation of uncertainties, with applications to both fission and fusion reactors. Thanks to this common scientific interest and background, a collaboration has been established with Westinghouse, aiming at the development and application of computational tools instrumentals to the industrial deployment of LFRs. The present PhD project will be focused on establishing a list of uncertainty sources that will include nuclear data, thermal hydraulics, manufacturing and other possible sources that could significantly impact the design and the performance of the Westinghouse LFR; in order to develop a computational framework that will allow to incorporate and assess the impact of these different sources of uncertainties for the Westinghouse LFR design involving system analysis, fuel rod performance, thermal-hydraulics and reactor physics modeling. To this aim, the most appropriate computational tools for LFR analysis will be used and complemented with state-of-the-art algorithms for uncertainty quantification and propagation. The goal of the project will be to advance the state-of-the-art of UQ&P analysis with the purpose to use the analysis results in the LFR safety analysis and design work. The workflow automatization and facilitation along with the methodology development/adaptation will be a critical part of the proposed PhD activities.

Skills and competencies for the development of the activity	The candidate should be familiar with the following topics: - Core physics of fission nuclear reactors, with special reference to fast neutron spectrum reactor - Deterministic and stochastic modelling approaches for steady-state and transient analysis of nuclear fission reactors The candidate should be able to cooperate and interact collaboratively in the research work environment.