NE-18-17592, Advanced Fuel Stability Analysis Using High-Fidelity Large-Scale Computational Fluid Dynamic Simulations

Nuclear fuel assemblies are predominantly exposed to high axial flow during operation. Under these conditions, the fuel assembly undergoes random vibration induced by the flow turbulence. The resulting turbulence excitation is well understood and has been accounted for at the design stage of the fuel assemblies, thus ensuring fuel mechanical integrity. For certain design and/or operating conditions, the fuel assemblies can be exposed to more complex flow conditions, which have led to significantly higher vibrations and, in some cases, fuel-rod fretting wear and failure. The grid-to-rod fretting wear induced by the mixed axial and localized cross-flow is of significant concern to plant operators.

The goal of this project is to deliver an attainable improvement in the safety and competitiveness of nuclear power energy generation by providing robust information about the flow patterns and formations throughout the simulated fluid domain and reducing nuclear plant operation costs by avoiding costly experiments that can only be performed for a limited number of reactor conditions. Framatome and Argonne National Laboratory will collaboratively develop and validate high-fidelity computational fluid dynamics models using U.S. Department of Energy Nuclear Energy Advanced Modeling and Simulation codes for the investigation of flow-induced vibrations of different fuel rod designs (standardized and advanced designs) to ensure the robustness of fretting wear performance. Ultimately, this capability will enable the accelerated delivery of advanced fuel forms to the light water reactor and advanced reactor fuel markets.