INTERNATIONAL NUCLEAR ENERGY RESEARCH INITIATIVE

Sodium-Cooled Fast Reactor Structural Design for High Temperatures and Long Core Lifetimes/Refueling Intervals

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Collaborators: None

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Project Abstract

The objective of this project is to develop state-of-the-art analysis capabilities for the high-temperature structural design of sodium-cooled fast reactors (SFRs). The research will focus on SFRs with higher core outlet temperatures than traditional SFRs (550°C or greater). These are desired attributes of the small, modular fast reactors intended for international deployment that will help meet the significant projected growth in nuclear capacity while reducing the risks of proliferation. However, at higher temperatures and longer service lifetimes the reactor structures may undergo creep and creep-fatigue and accumulate inelastic strain as the reactor goes through operational cycles and transients. Structural stability of the reactor vessel and in-vessel components must also be assured during seismic events.

This project will investigate the design of core, vessel, and in-vessel structures using the SIE ASME-NH computer code developed at KAERI, that implements the rules of ASME Boiler and Pressure Vessel Code Section III, Subsection-NH and incorporates deterministic analyses of material inelastic behavior. Researchers will also carry out seismic and buckling evaluations at high temperatures.

The approach represents an advanced development in engineering structural design technology that enables researchers to investigate ways of reducing the conservatism inherent in the elevated temperature design rules. It also facilitates comparisons of the simplified elastic analysis and the detailed inelastic analysis methods. Researchers will specify thermal loadings for operational cycles and transients expected during the plant lifetime. It is initially planned to use the 50 MWe (125 MWt) Small Modular Fast Reactor (SMFR) concept developed by an international team including ANL as the reference SFR design. The capabilities the team develops will also be applicable to other high-temperature Generation IV reactors.