SMR L.L.C (Holtec International)
partnered with
Oak Ridge National Laboratory

NE-20-23665, Coupled Neutronic and Thermal Hydraulic Analysis of a Natural Circulation Based Small Modular Reactor Using VERA-CS

YEAR AWARDED: 2020

TOTAL PROJECT VALUE: $500k (DOE: $400k, SMR, L.L.C.: $100k)

STATUS: Completed

PRINCIPAL LAB INVESTIGATORS: Aaron Graham (ORNL), Rick Trotta (SMR)

DESCRIPTION: SMR, LLC is a wholly owned subsidiary of Holtec International, whose mission includes establishing management of reactor projects and promoting global acceptance of the SMR-160 small modular reactor design. As the SMR-160 design fully relies on natural convection for maintaining coolant flow -- eliminating the need for coolant pumps and external coolant loops inherent to conventional pressurized water reactor designs -- it raises operational challenges related to neutronics of the steady-state core and its thermal-hydraulics. This GAIN voucher-supported work was to analyze reactor core and system behavior in response to anticipated transients and accident scenarios. It also provided an opportunity for the SMR-160 team to use the Virtual Environment for Reactor Applications (VERA) code suite, which employs multi-physics simulation to model feedback behavior in the reactor core. Oak Ridge National Laboratory has demonstrated past expertise with the VERA code suite and supports new emerging designs by applying VERA capabilities.

BENEFIT: Collaboration was to provide steady-state, code-to-code comparisons and benchmarking for core physics codes. VERA has a key advantage of coupling between its communicative counterparts, providing a multi-physics simulation capable of capturing feedback behavior in the reactor core. The coupled physics simulations produce higher resolution results, which help better evaluate margins to safety limits.

IMPACT: The work was conducted in four phases. A VERA model was created using information provided by Holtec. Comparisons between VERA and the Holtec system analysis tools were conducted, followed by hot zero power and hot full power comparisons. The third phase was to compare VERA with the Holtec tools for depletion calculations from all five cycles. The fourth phase involved simulating a main steam line break and a rod ejection accident with VERA and the Holtec tools, to confirm the accuracy of the Holtec tools for a rapidly evolving transient. In both cases, VERA was used to generate pin-level data that could not be generated by the Holtec tool. The pin-level data are useful for determining whether there is any potential for fuel failure during the transient.

SIGNIFICANT CONCLUSIONS: These calculations provided a much more detailed look at the fuel performance to ensure that there is no risk of fuel failures in either transient.

NEXT STEPS: VERA models and results were handed off to the Holtec for further work on the SMR-160.