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HFIR Conversion to LEU UMo Monolithic Fuel: Activities to Support Steady-State Safety Margin Evaluation

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ABSTRACT

The Oak Ridge National Laboratory (ORNL) High Flux Isotope Reactor (HFIR) is a multi-faceted reactor that delivers world-class performance in a variety of fields such as material irradiation, isotope production and neutron scattering. The reactor, in operation since 1965, currently uses highly-enriched uranium (HEU) fuel enriched at 93 wt. %. HFIR is one of the five U.S. High Performance Reactor (USHPRR) expected to convert to the new UMo "monolithic" fuel, currently under development. Argonne National Laboratory (ANL) is actively collaborating with ORNL to help identify and solve some of the unique technical challenges associated with the HFIR conversion project.

Currently, steady-state thermal-hydraulic safety margins are evaluated with the ORNL code HSSHTC. This is a very sophisticated one-dimensional heat transfer code specific to HFIR and tailored to HEU fuel able to model plate deflections, oxide growth, fuel swelling and also to model the effect of fuel defects. Consequently, safety margin evaluation for low-enriched uranium (LEU) fuel requires the implementation and validation of a significant number of modifications to the original calculation scheme.

In addition, since HSSHTC does not explicitly model transverse heat conduction/convection, the solution may be impacted by the degree of discretization of the power distribution. The margins differences calculated using coarse or detailed power distribution can be particularly pronounced on the fuel edges. Importance of conduction/convection must therefore be well understood in order to prevent too optimistic or too conservative margin evaluation.

The paper will present the results of some of the ongoing activities intended to overcome these difficulties: Modeling the impact of fuel defects on heat flux distribution for HEU and LEU fuel and assessing importance of heat conduction and convection using three-dimensional Computational Fluid Dynamics codes.