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Application of CFD to the Steady-State Thermal-Hydraulics Analyses for RHF Fuel Conversion

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ABSTRACT

In collaboration with Argonne National Laboratory (ANL), the Institute Laue-Langevin (ILL) identified an LEU fuel element design that would meet safety and performance criteria, making feasible the conversion of the *Réacteur à Haut Flux* (RHF) in Grenoble, France. The thermal-hydraulics analysis for that LEU design was performed using 3D computational fluid dynamics (CFD).

However, in the conversion of research reactors, ANL has historically calculated steady-state thermal-hydraulic margins with the 1D PLTEMP code using hot channel factors (HCF's) to statistically account for uncertainties and design tolerances. Given that the RHF fuel element contains a large radial power peaking factor occurring near the outer unheated edge of the plates, the lateral heat conduction in the fuel plate and coolant mixing in the channel are important factors in determining thermal-hydraulic limits (i.e. maximum cladding temperature and margins to the onset of nucleate boiling and flow instability).

The purpose of this work was to take the same HCF approach used by the PLTEMP code and apply it to CFD simulations and quantify the conservatism that can be removed by including lateral conduction and convection. This was addressed by first comparing results from a "1D" CFD model against the 1D PLTEMP code to show both are in reasonable agreement. Additional CFD models were created to separately quantify the impact of lateral conduction and convection and to show that a flat plate geometry is a good approximation to the involute curve. The HEU and LEU designs are compared.