

Coupling between the system-scale and local-scale thermal-hydraulics solvers CATHARE and NEPTUNE_CFD

Chai Koren¹, Clotire Geffray², Mathieu Guingo^{1*},

¹Electricité de France, R&D Division, 6 Quai Watier, 78401 Chatou, France

²Commissariat à l'Energie Atomique et aux Energies Alternatives, Saclay, France

So-called system-scale codes (such as the CATHARE, RELAP, or TRACE codes) are commonly used in the nuclear energy industry to analyze numerically the global behavior of a nuclear reactor in a reasonable computational time, in particular for safety studies. Due to the relatively coarse spatial discretization of the computational domain used in this kind of simulations, local thermal-hydraulics phenomena are usually not captured by the computations. Concurrently to the used of system-scale thermal-hydraulics codes, in recent years, the development of local-scale, CFD (Computational Fluid Dynamics) codes have made it possible to simulate a wide range of nuclear thermal-hydraulics applications, involving either single- or two-phase flows. This paper aims at presenting the coupling methodology developed between the two numerical tools developed in the NEPTUNE project (a joint R&D initiative sponsored by the main actors of the French nuclear civil industry: EDF, CEA, Framatome, and IRSN), namely the system-scale thermal-hydraulics CATHARE code and the local-scale, CFD tool NEPTUNE_CFD. First, the principle of the coupling is described. Secondly, in order to assess the quality of the numerical implementation, a collection of various verification test-cases are presented. Finally, the CATHARE/NEPTUNE_CFD coupling is applied to a validation test-case in order to illustrate how this kind of methodology can contribute to improve system-scale simulations within an acceptable computational time.