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# ALFRED DHR system scaling verification and numerical pre-test analysis

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Passive safety systems are used in generation III+ evolutionary reactors and in generation IV advanced reactor designs, especially for the decay heat removal following an accidental event. These systems allow with one or more loops the heat transfer from the primary system to the external environment through the natural circulation of fluids or through boiling and condensation phenomena. A limitation of these systems is the lack of intrinsic mechanisms that allow the passive control of the power removed, and this is particularly important for reactor designs that involve the use of liquid metals as a coolant, as the solidification temperature is always higher than the temperature of the ultimate heat sink. Under these circumstances, there is the possibility that the primary system coolant may freeze in the colder regions of the system, opposing to the natural circulation of the fluid and in eventually inducing mechanical stresses due to the volume variation between liquid and solid state. Ansaldo Nucleare has patented a passive safety system for the ALFRED reactor that allows to control the power removed to the environment by making use of non-condensable gases placed in strategic positions of the safety system. The DHR system consists of 3 loops, each connected to one steam generator through the feedwater and the steamline. These circuits have an isolation condenser immersed in a pool and connected to an expansion tank. During safety system operation, the non-condensable gases are passively transported in the system between the tank and the isolation condenser proportionally to the decay heat, degrading the heat transfer in the condenser and strongly delaying the onset of solidification in the primary coolant. This paper is based on the scientific effort dedicated through the European H2020 PIACE project and reports the scaling verification of the decay heat removal system to be carried out at the SIRIO experimental facility. Pre-test analyses performed by means of the RELAP5-3D system code are presented, assessing the applicability of an existing facility configuration to the revised design of the DHR system of ALFRED. The results show how the experimental facility is able to represent the most important phenomena underlying the operating principle of the system such as pressure behaviour, noncondensables gas transport and coolant temperature control above solidification point.

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