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Optimization of the secondary loops on the ESFR SMART project

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The ESFR SMART project is a European sodium fast reactor project, which follows on from the EFR project, then the CP ESFR project, and whose goal is to present an improved project in terms of safety, taking into account the new rules to be applied in particular following the post Fukushima provisions. For the primary circuit a number of safety options have already been presented (ref 1, 2, 3), based on simplifications as well as passive and forgiving systems. In the same spirit, this paper proposes an optimization of the secondary circuits to improve their intrinsic safety and their compactness.
First, these circuits have the role of evacuating the power of the reactor, and in case of shutdown will actively participate in the evacuation of the residual power. The use of these circuits has been favored because it is the loop commonly used by the operator for this purpose, and in all operating circumstances. They were therefore pre-dimensioned (ref 4 , 5) to be able to evacuate this power alone even after the loss of the water circuits, only by natural convection of the air around the modules of steam generators. Moreover, in each secondary loop a dedicated system connected to the exchanger is capable of performing this function on its own, in passive natural convection and even in the event of draining of the secondary circuit.
Second, the REX of the SFRs shows that sodium leaks mainly take place at the level of the secondary circuits .Proposals are made for the secondary piping to increase the possibilities of rapid detection and mitigation . For this, we propose to use straight pipes where the expansions are taken up by bellows. This helps to minimize lengths and welds. This also allows the use of an offset thermal insulation allowing a quick and more reliable sodium leak detection. This point greatly improves the compactness of the circuit and therefore makes it possible to significantly reduce secondary buildings.
Then, for the sodium / water reactions, the choice of modular steam generator has been made to increase quickness of detection at the outlet of each module. It allows also minimizing consequences on the operation of the reactor able to operate with one unavailable module
Finally, some propositions are made on the use of passive thermal pump to assure passively a minimal sodium flow rate.
The conclusion summarizes the necessary R&D to allow this optimization.

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