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Status of severe accident studies at the end of the conceptual design: feedback on mitigation features

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The ASTRID reactor developed by the CEA with its industrial partners, will be used for demonstration of the safety and operability, at the industrial scale, of sodium fast reactors of the 4th generation. Among the goals assigned to ASTRID, one is to improve the safety and the reliability of such reactor (compared to previous sodium-cooled fast reactors). Among the innovations promoted in the ASTRID design, a low sodium worth core concept (CFV core) has been developed. By means of various design provisions enhancing the neutron leak in case of sodium draining, the overall sodium void effect of the ASTRID core is near zero and could even be negative. Additionally, mitigation devices should be implemented into the core in order to limit the calorific energy released in the fuel during the secondary phase of the accident.

This paper deals with a synthesis of severe accidents studies performed during the second period of the pre-conceptual design stage of the ASTRID project (2013-2015). The main insights of the studies in term of mitigation strategy and of mitigation device design are highlighted in the paper. The core transient behavior has been investigated in case of generalized core melting situations initiated by postulated reactivity insertion ramps (UTOP) and unprotected loss of flow (ULOF). In case of postulated reactivity insertion ramps, the mechanical energy release assumed to be released by molten fuel vapor expansion does not exceed several tenths of megajoule ULOF transient does not lead to energetic power excursions neither thanks to the mitigation provisions and to the core design. Moreover, the ULOF early boiling phase leads to core power decrease. Thus, the primary phase of the accident is not governed by a power excursion. The paper deals with the approach and the presentation of preliminary findings regarding mitigation provisions. Those provisions are investigated by considering a core degraded state representing the end of the transition phase. The scenario possible evolutions from this degraded state provide the following parameters: mass and temperature of molten materials, mass and flow rate of materials relocated on the core catcher and possible ejected material mass above the core. Those parameters are used for the determination of approximate loadings for the primary vessel and for the design of the core catcher. Finally, a methodology and first results dedicated to assess the efficiency of mitigation device design is presented as well as first preliminary results of checking process.

Country/Int. Organization

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