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Minimisation of Reactivity Margin for Equilibrium Core of Liquid Metal Cooled Fast Reactors

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Maximum reactivity margin describes the scale of potential nuclear danger of reactor unit at its release and the scale of measures that must be taken to compensate by control and safety systems, to minimize the probability of such accidents and to limit the consequences. "PRORYV"project not only sets the goal of minimizing consequences but also eliminating the root cause of reactivity accident.
This paper presents the results of systematic analysis of consequences of reactivity accidents caused by an uncontrolled escape of the total accumulated reactivity in fast reactors with lead and sodium coolants. The following criteria describe minimization of reactivity margin:
• conditions for preserving the wholeness of fuel rods or reactor body;
• elimination of accidents requiring people evacuation and relocation.
In the first case it's shown that if the induced reactivity is at ⊠eff (0.6–1 ⊠eff) level the power of feedback is enough to avoid exceeding the safety operation limits of rod shell temperature. Therefore, this conservative criterion rules out that the initial event of reactivity implication will grow into a nuclear accident.
The second criterion is less conservative. DINAR and COREMELT computational software that have proper mathematical models has been used for analysis of accidents caused by higher reactivity implication. It's shown that there can be set less strict reactivity limits. Particularly for sodium reactor reactivity margin can be increased up to 0.75%⊠k/k.
Maximum reactivity margin has been analyzed for influence on requirements to CPS devices. It was shown that reactivity margin should be lowered in terms of nuclear safety especially if reactor unit power increases to 1200 MW (and higher).
Minimization of reactivity margin is possible in terms of the so-called concept of "equilibrium reactor core" (decrease of reactivity margin for burn out) and with the use of high heat transfer fuel with liquid metal layer (temperature to power phenomena). The paper specifies "equilibrium reactor core"term, analyzes implementation possibilities and "transition"problems solutions: dependency from initial isotope composition of Pu, uncertainties of fuel parameters and forecasted properties of reactor core.

Country/Int. Organization

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