MODELING OF EXCESS REACTIVITY TRANSIENTS IN THE SEALER LEAD-COOLED REACTOR

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ABSTRACT

Small Modular Reactors (SMRs) have been considered an attractive source of energy in recent years, due to their claims of inherent safety systems and lower capital cost as compared to larger conventional reactor designs. A number of small reactor concepts have been proposed, and many of them are based on advanced technologies. A thorough evaluation of each concept must be performed before a decision can be made regarding its suitability to a particular set of technical or environmental requirements, economics, and social conditions. From the technical perspective, a substantial component of such evaluations is the assessment of possible incidents related to reactor operation, and the evaluation of hypothetical accident scenarios. Analysis of excess-reactivity transients is generally an important part of the reactor safety assessment.

Several SMR concepts are based on the use of liquid-metal coolant technology, in particular lead. One of these designs, named SEALER (Swedish Advanced Lead Reactor), has been proposed to be built in Canada. The concept was developed by Dr. J. Wallenius, founder of LeadCold Reactors [1]. SEALER is a fast neutron spectrum lead-cooled reactor, which uses UO_2 enriched to 19.9% as fuel. According to its designers, the reactor can operate at 8 MWth for 30 years, or 30 MWth for 10 years without refueling (at 90% availability) [2]. The reactor uses 12 assemblies containing control rods, which would be slowly extracted from the core during operation, maintaining reactor criticality as the fuel burns up. The SEALER reactor was first modeled using

SERPENT 2.1.26 [3], and the main reactor characteristics were compared with published data [1]. The SEALER reactor schematic is shown in **Figure *1***.

In this paper, two postulated reactivity transients were modeled for the SEALER reactor concept. First, the reactivity transient due to the leakage of steam from a steam-generator to the coolant, and subsequently to the core was modeled using the SERPENT code. In addition, the reactivity transient due to inadvertent removal of the control rod assembly was simulated with the DONJON and DRAGON codes. In order to simulate the inadvertent removal of the control rod assembly, a SEALER reactor model was created for the DONJON 5.0.2 full core diffusion code [4], using macroscopic cross-section data generated with the DRAGON 4.1.1 lattice code [5].

The studies will provide information regarding the void reactivity worth due to the steam accumulation in the core. Localization of void in one region of the core and a uniform distribution of void in coolant across the reactor core will be considered. Also, the effect of the inadvertent removal of the control rod assembly on the neutron multiplication factor and reactor power will be shown.

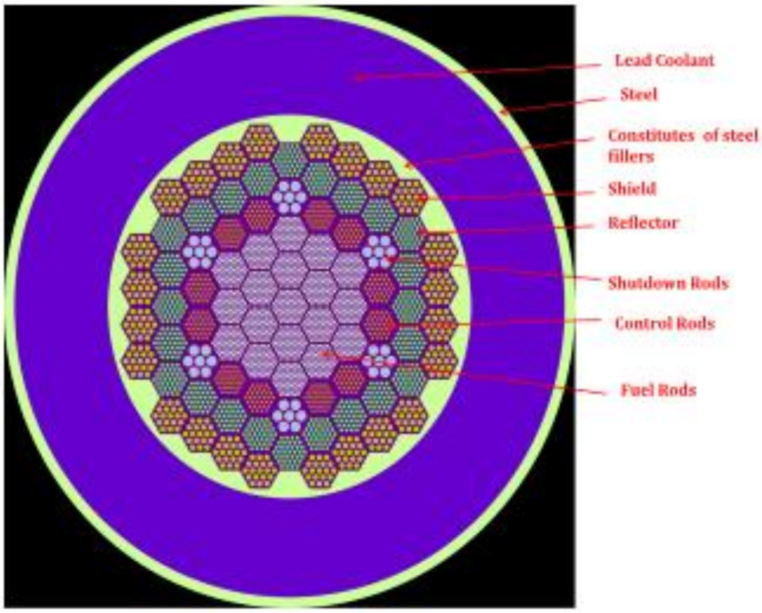

Figure 1: The SEALER Core Layout in the SERPENT Model

References

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