

Stochastic Safety Limits and Scale-Dependent Power Fluctuations in Nuclear Reactors: A Critical Scaling Approach

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Abstract

Applying boundary functionals of random risk processes to various physical problems makes it possible to determine many important characteristics of these problems. For example, a special case of boundary functionals is the time to first reach a level, which is widely and successfully applied to a variety of problems. We consider the application of boundary functionals to solving nuclear safety problems. In situations such as reactor startup, as well as for certain types of reactors, neutron behavior changes. Neutron clustering begins to play an important role, and the distributions characterizing neutron behavior change. The normal Gaussian distribution is replaced by stable limiting distributions to which the sums of random variables converge. Boundary functionals allow us to accurately calculate the statistics of random events, determine the behavior of reactor power peaks, the probabilities of catastrophic power surges, and other quantities important for reactor safety, providing a mathematical bridge between the abstract theory of directed percolation and engineering calculations of protection parameters. This article examines the firstpassage time to reach a certain level.

Note: Figure translations are in progress. See original paper for figures.

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