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Nuclear Fuel Safety Threshold Determined by Logistic Regression Plus Uncertainty

Authors : D. S. Gomes, A. T. Silva

Abstract : Analysis of the uncertainty quantification related to nuclear safety margins applied to the nuclear reactor is an important concept to prevent future radioactive accidents. The nuclear fuel performance code may involve the tolerance level determined by traditional deterministic models producing acceptable results at burn cycles under 62 GWd/MTU. The behavior of nuclear fuel can simulate applying a series of material properties under irradiation and physics models to calculate the safety limits. In this study, theoretical predictions of nuclear fuel failure under transient conditions investigate extended radiation cycles at 75 GWd/MTU, considering the behavior of fuel rods in light-water reactors under reactivity accident conditions. The fuel pellet can melt due to the quick increase of reactivity during a transient. Large power excursions in the reactor are the subject of interest bringing to a treatment that is known as the Fuchs-Hansen model. The point kinetic neutron equations show similar characteristics of non-linear differential equations. In this investigation, the multivariate logistic regression is employed to a probabilistic forecast of fuel failure. A comparison of computational simulation and experimental results was acceptable. The experiments carried out use the pre-irradiated fuels rods subjected to a rapid energy pulse which exhibits the same behavior during a nuclear accident. The propagation of uncertainty utilizes the Wilk's formulation. The variables chosen as essential to failure prediction were the fuel burnup, the applied peak power, the pulse width, the oxidation layer thickness, and the cladding type.

Keywords : logistic regression, reactivity-initiated accident, safety margins, uncertainty propagation
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