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Reduced Order Stress Model for Interactive Maneuvering Guide for Boiling Water Reactors

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Abstract

Strong pellet-clad interaction resulting in high stress in the cladding is one of the lead causes of preventable fuel failure in boiling water reactors. As corrosive agents, mainly compounds of iodine released from the irradiated pellets, can be assumed to be always present, strategies for preventing stress corrosion cracking due to strong pellet-clad interaction rely mainly on controlling clad stress levels. This has been traditionally accomplished using plant operation guidelines that restrict power maneuvering and limit the ramping rates. Such guidelines are based on extensive power plant experience and in-reactor ramp tests, and are updated to reflect advances in fuel design such as the introduction of clad liners. On the other hand, detailed fuel rod thermal-mechanical codes would provide far better resolution of the variables that control the process of stress corrosion cracking, but the computer resources they require make their online application prohibitive for the foreseeable future. In this paper, a reduced order model is introduced that combines the advantages of a heuristic maneuvering guide speed and approaches the accuracy of a fuel rod thermal-mechanical code by the selective representation of a small number of state variables important to predicting hoop stress levels. The new model is suitable for online monitoring, and can be helpful in simultaneously reducing the probability of fuel failure and improving maneuvering flexibility.