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Improvements in Transient Testing Reactor (TREAT) with a Choice of Filter

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Abstract

The safe and reliable operation of nuclear reactors has always been one of the topmost priorities in the nuclear industry. Transient testing allows us to understand the time-dependent behavior of the neutron population in response to either a planned change in the reactor conditions or unplanned circumstances. These unforeseen conditions might occur due to sudden reactivity insertions, feedback, power excursions, instabilities, and accidents. To study such behavior, we need transient testing, which is like car crash testing to estimate the durability and strength of a car design. In nuclear designs, such transient testing can simulate a wide range of accidents due to sudden reactivity insertions and helps study the feasibility and integrity of the fuel used in certain reactor types. This testing involves a high neutron flux environment and real-time imaging technology with advanced instrumentation with appropriate accuracy and resolution to study the fuel slumping behavior. With the aid of transient testing and adequate imaging tools, it is possible to test the safety basis for reactor and fuel designs that serves as a gateway in licensing advanced reactors in the future. To that end, it is crucial to fully understand advanced imaging techniques both analytically and via simulations. This paper presents an innovative method of supporting real-time imaging of fuel pins and other structures during transient testing. The major fuel-motion detection device that is studied in this dissertation is the Hodoscope which requires collimators. This paper provides 1) an MCNP model and simulation of a TREAT core with a central fuel element replaced by a slotted fuel element that provides an open path between test samples and a hodoscope detector, and 2) a choice of good filter to improve image resolution.

Keywords: Hodoscope, transient testing, collimators, MCNP, TREAT, hodogram, filter