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#4-112 Assessment of Thin Plastic Scintillation Detectors to Improve Fission-Product Beta-Particle Measurements for the Advanced Test Reactor Critical Facility Power Distribution Measurements

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The Fission Wire Measurement System is a custom measurement system designed in the 1960s to measure the beta-particle activity of irradiated uranium-aluminum fission wires. This measurement is conducted to determine the fission rate profile of the Advanced Reactor Test Critical facility. The Advanced Test Reactor Critical facility is an open-pool, low-power test reactor used to qualify experiment configurations and verify core models prior to full-power experiment irradiations in the Advanced Test Reactor. Power distribution measurements in ATR-C use uranium-aluminum wires that are distributed throughout the core to validate simulation and modeling results. These measurements require from 340 to 1500 wires to be irradiated and measured within a 12-hour window. The system consists of 4 measurement channels and one reference channel, each with a 2-pi proportional gas flow detector and the measurement channels each have an automated sample changer. The gas flow detectors are of a custom design for this detector system that use methane gas with a large anode wire compared to modern proportional counters. These detectors, which are nearly 60 years old are irreplaceable. The measurements from these gas detectors are affected by the gas flow rate, atmospheric and line pressure, and are very sensitive to the applied high voltage. Recent improvements have been made to the control and data acquisition system, but the detectors have remained the same. The nature of the measurement of the fission product decay activity is such that the energy spectrum of the signal is changing with time. Thin, 250-um thick, plastic scintillators were commercially obtained as a potential replacement for the gas flow detectors. The original calibration of the uranium-aluminum fission wires was conducted in 1965 using a series of irradiations of gold foils and the wires in a well-characterized thermal neutron field. These measurements provided a time-dependent fission rate conversion factor from the gold foil data to calibrate the fission wires based on the response from the 2-pi proportional gas detectors. Transitioning to the new detectors requires qualification and testing. The sensitivity of the scintillators to changes in the energy spectrum of the fission wires and translation of the calibration factor have been completed. These measurements indicated that the sensitivity of the scintillators over time changes at a different rate than the sensitivity of the gas flow detectors. However, the inverse activity of measurements of both detector types is linear with time. Initial results indicate that the scintillator detectors will be a sufficient replacement for the gas detectors with minor adjustments to the fission rate conversion factor. Replacement of the detectors will improve the fission wire measurements and provide a more stable and reliable measurement system.

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