Development and Testing of an Open-Loop Oscillator for Small Reactivity Worth Samples

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ABSTRACT

There is a need for integral physics data on reactivity worth of minor actinides (transmutation studies) and fission products (burn-up credit). With regard to minor actinide worths, it is necessary to perform measurements in prototypical spectra, most likely fast. At the present time however, there are no fast spectrum facilities in the United States to use for such measurements. These measurements are needed for data validation in support of advanced nuclear system designs; however, they are very difficult to perform, and it is even more difficult to assess the precision. Successful completion of this project will hopefully demonstrate a simpler way to achieve needed data that can be ported to other facilities.

In France, the MINERVE facility has been used for low-worth reactivity measurements in different spectra by using a closed-loop oscillator technique. In the 1980's, the MINERVE "chimney" was loaded with fast reactor fuel from the MASURCA reactor, and oscillation experiments were performed (but not on minor actinides of current interest). However, it has been determined that using MINERVE with a fast spectra is not feasible again because (1) the safety issues of using MASURCA fuel in MINERVE are deemed too difficult, and (2) it is virtually impossible to decouple the experiment zone (fast spectrum) from the driver zone (water moderated), particularly when very small reactivity worth samples are being studied (fractions of a cent).

The ideal situation would be to use MASURCA itself for these types of measurements. However, building and installing a MINERVE type oscillator would be very expensive, because it would require a closed-loop feedback control rod. In theory, an open-loop measurement system (far simpler and much less expensive) could be as accurate, but this needs to be demonstrated in practice. This project uses both types of systems in order to make a direct comparison of precision. If it can be demonstrated that the open-loop technique is as accurate as the closed-loop feedback, then installation of such a system in other reactor facilities (e.g., ATR-C, MASURCA) could be considered.