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Progress on U.S. High Performance Research Reactor LEU Fuel Element Designs

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ABSTRACT

Based on favorable irradiation behavior, U-10Mo monolithic alloy fuel has been selected for qualification in the LEU conversion of the U.S. high performance research reactors (USHPRR). Irradiation behavior has previously been demonstrated in test plate geometry across a range of irradiation conditions similar to those found in the current USHPRR. Based on the initial success of this fuel system, LEU monolithic alloy fuel element designs for the USHPRR LEU conversion cores have been optimized by each reactor facility to allow these reactors to meet mission, operational, and safety basis requirements using LEU fuel.

The reactors regulated by the U.S. Nuclear Regulatory Commission (NRC) have each undertaken a Preliminary Safety Analysis Report (PSAR) for conversion to LEU fuel. The PSAR will review the analysis methods in advance of fuel qualification, and establish the assumed safety basis requirements to be met through fuel specifications and later fuel performance data. The PSAR for NBSR reactor conversion at the National Institute of Standards and Technology (NIST) was completed by Brookhaven National Laboratory and NIST. This PSAR has been submitted to, and is under review by, the NRC. In the past year the University of Missouri Research Reactor (MURR) has, with support from Argonne National Laboratory (ANL), completed and submitted a PSAR to the NRC and review is expected to commence in 2018. The Massachusetts Institute of Technology (MIT) Nuclear Reactor Laboratory staff have completed technical basis documents with support from ANL, and a PSAR is in preparation. The Advanced Test Reactor (ATR) and High Flux Isotope Reactor (HFIR) are operated and regulated by the U.S. Department of Energy (DOE) at the Idaho and Oak Ridge National Laboratories, respectively. These reactors are in the process of completing design safety analyses. ATR is now completing a conceptual conversion core design, and for HFIR design optimization has been completed across a broad range of options, including exploration of U_3Si_2 dispersion fuel, that allows for a selection of the most suitable LEU design to fabricate and operate.

Conversion fuel assembly design is a critical step in the USHPRR program since the program fabrication process demonstration, and subsequent irradiation testing at mini-plate, full-size plate, and fuel assembly levels is planned across the range of reactor-specific proposed LEU plate geometries and irradiation conditions.