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UPDATES ON THE MIT RESEARCH REACTOR (MITR) CONVERSION FROM HIGHLY ENRICHED URANIUM TO LOW ENRICHED URANIUM FUEL

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ABSTRACT

The Massachusetts Institute of Technology Reactor (MITR) is a 6 MW research reactor operating with highly-enriched uranium (HEU) finned plate-type fuel. It delivers a neutron flux comparable to light water reactors in the compact core, and has demonstrated track record in performing advanced materials, fuel, and instrumentation irradiation tests in light water reactors or high temperature reactors conditions. The conversion objective is to design a low-enriched uranium (LEU) fuel element that could safely replace the current 15-plate HEU fuel element and maintain performance while requiring minimal changes to the reactor structures and systems. Selected monolithic U-10Mo LEU fuel design is a 19-plate unfinned fuel element with increased cladding thickness and thinner fuel meat thickness on the outer plates. The LEU fuel design has been shown to deliver 7 MW safely to maintain the neutron flux performance of the 6 MW HEU core. The preliminary safety analysis report (PSAR) is near completion and is scheduled to be submitted to the U.S. NRC in 2017. A transition core plan, from 22 fresh LEU elements gradually to 24 elements equilibrium core configuration, is being evaluated to ensure all core parameters can be maintained within the safety envelope during conversion. The current study presents fuel cycle development work supporting the transition core plan. The computer code package MCODE-FM (MCNP-ORIGEN Coupled Depletion Program – Fuel Management) is adopted for the neutronics modeling. In particular, a fixed pattern refueling scheme was evaluated, where three fresh LEU fuel elements and three end-of-life elements are regularly introduced and discharged after each 10-week power cycle. Total of 14 fuel cycles have been simulated. Results shows that an equilibrium core is achieved after seven fuel cycles. Preliminary results indicate adequate margin is maintained below the proposed fission density limits of three different MITR U-10Mo plate configurations, and significant safety margin to onset of nucleate boiling for all transition and equilibrium cores.